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A GEOGRAPHY OF THE BRITISH ISLES

WITH NUMEROUS PRACTICAL EXERCISES

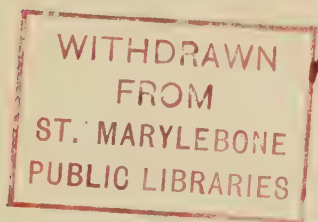
BY

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PREFACE.

IN planning and writing this book, the author has had two aims continually before him. The first was to present material from which conclusions of geographical significance can be derived, so that the pupils can learn by doing. This educational principle, however, is only of partial application to Geography, because the pupils cannot be taken from place to place throughout the land to observe the physical features, the local industries, and the course of trade for themselves. All that can be done is to place before them impartial records from which they can extract the essential facts and relations between facts. These records are maps and statistics. The extent to which this method can be followed depends upon how far maps and statistical tables convey a real and vivid meaning to the pupils. A previous study of the maps of their own district, in the open air, on the lines of the work in Simmons and Richardson's *Introduction to Practical Geography*, and some experience in the compiling of statistical tables from facts directly observed, are essential to the full success of the methods here adopted.

The second aim was to follow a progressive method, so that the earlier lessons should reveal general principles applicable to the later lessons. This led to two features which in a text-book of the old-fashioned, gazetteer type would have been serious defects; namely, the much greater space devoted to the earlier areas than to the later, and the occasional overlapping in the areas covered in different lessons. The latter feature

results from the endeavour to impress upon the pupil the inter-relation of the two natural methods of dividing the land—by river-basins and by geological formations. It will be noticed that, in the descriptive sections, very little attention is paid to the artificial division into counties. The practical work in representing graphically, on the map, statistics prepared on a county basis, should afford sufficient practice to impress the positions and areas of the counties on the pupil, without any need of formal description.

The statistical tables have been prepared from the official Census Reports, and the various annual Reports of the Board of Trade, the Boards of Agriculture (for Great Britain and Ireland) and the Home Office. The form in which these statistics are issued is not often suitable for teaching purposes, and a large amount of calculation has been necessary to produce the tables in this book. Though in some cases the statistics are not actually the most recent available, they are typical of the evidence upon which geographical conclusions are based, and later numbers would not essentially modify the results obtained. The statistics of ship-building are taken from those published annually by the *Glasgow Herald*. The maps of the Ordnance and Geological Surveys form the basis of all the maps.

The teacher making use of the exercises in class, may discover some practical difficulties overlooked by the author, who will be grateful for any information that may help in improving a future edition. The time required for carrying out each set of exercises varies from lesson to lesson; but it is hoped that, should any lesson be too short, suitable additional material will be found in the supplementary exercises.

For assistance in preparing particular parts of the work the author is indebted to Prof. J. W. Gregory, F.R.S., Prof. C. G. Cullis, Prof. H. H. Swinnerton, and particularly Dr. A. Wade. For the photographic views reproduced he has to express his hearty thanks to Prof. W. W. Watts, F.R.S., Prof. S. H. Reynolds, Dr. Vaughan Cornish, the late Mr. A. E. V. Zealley, Mr. J. H. Pledge, Dr. H. Edwards, and Mr. Wade. In Figs.

18, 55, 70 and 86 he has adopted, with modifications, a code of dots and dashes for indicating the altitude of contour-lines, invented by Prof. Cullis. Lastly, he is indebted to the Editors of the series, Sir Richard Gregory and Mr. A. T. Simmons, for much information, advice and criticism and many valuable suggestions. For the imperfections from which, in spite of all this friendly help, the book is not exempt, he is alone responsible.

A. MORLEY DAVIES.

The publication of the preliminary reports on the Census of 1921 has made it possible to bring a few of the statistical tables up to date, but in view of the many abnormal conditions still prevailing as the result of the war, it has been thought inadvisable to replace any of the tables dealing with production until more stable conditions are restored.

A. M. D.

5th May, 1922.

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MATERIALS REQUIRED FOR PRACTICAL WORK.

1. An Atlas containing complete maps of England and Wales, Scotland and Ireland.
2. The Geological Map of the British Islands, published by the Geological Survey. (Price 2s. a single copy, but 1s. if a number are purchased together.)
3. (Optional.) Bartholomew's "Touring Atlas of the British Isles" (1s.). (The few exercises requiring this atlas can be omitted if necessary.)
4. A number of outline-maps of England and Wales, Scotland and Ireland, showing the counties.
5. Squared paper (inches and tenths).
6. Squared tracing paper.
7. Drawing-board and T-square.
8. Drawing-paper and pins.
9. Mathematical instruments (compass, dividers, protractor and inch-rule).
10. Pencils H and HB, and at least two coloured pencils, red and blue.

N.B.—All loose pieces of paper on which drawings are made—whether squared paper or drawing-paper—should be cut of uniform size, or, in the case of long sections, so that they can be folded to this standard size. They can then either be pasted into a note-book, or kept together in a portfolio-file.

KEY TO POPULATION-SYMBOLS USED IN THE MAPS.

Towns with more than 1,000,000 Population are shown thus										⚡
"	"	500,000—1,000,000	"	"	"	"	"	"	"	✱
"	"	250,000—500,000	"	"	"	"	"	"	"	✱
"	"	100,000—250,000	"	"	"	"	"	"	"	★
"	"	50,000—100,000	"	"	"	"	"	"	"	✱
"	"	10,000—50,000	"	"	"	"	"	"	"	+
"	"	5,000—10,000	"	"	"	"	"	"	"	人
"	"	less than 5,000	"	"	"	"	"	"	"	●

NOTE ON THE NAMES OF GEOLOGICAL FORMATIONS.

For geographical purposes it is not necessary to distinguish as many different geological formations as are shown upon the geological map. The following table explains the relation of the terms used in this book to those used on the geological map recommended for practical work.

NAMES OF FORMATIONS USED IN THIS BOOK.	GEOGRAPHICAL FEATURES ASSOCIATED WITH THEM.	NUMBERS ON GEOLOGICAL MAP.
Alluvium - - - -	Fenland - - -	28
Glacial Drift (including Boulder-Clay) - - -	} - - - - -	not shown
Tertiary { Crag - - - -		
Beds { Bagshot Sands - -	Heaths and Forests - -	27
{ London Clay - - -	- - - - -	} 26
{ Woolwich Beds - -	- - - - -	
Chalk - - - -	Downs and Wolds - -	25
Upper Greensand - - -	- - - - -	} 24
Gault - - - -	Clay-vale - - -	
Lower Greensand - - -	Heathy ridges - -	23
Weald Clay - - -	Clay-vale of Weald - -	} 22
Wealden Sands - - -	Central ridge of Weald -	
Oolites - - - -	{ Oxford clay-vale - -	} 21
	{ Oolite ridge - - -	
Lias - - - -	{ Marlstone ridge - -	} 20
	{ Lias clay-vale - - -	
New Red Marl - - -	Great Red Plain - -	} 18, 19
New Red Sandstone - -	Ridges in the Plain - -	
Magnesian Limestone - -	- - - - -	18'
Coal Measures - - -	Coalfields - - -	17
Millstone Grit - - -	Moors - - - -	16
Carboniferous Limestone -	{ Dry uplands - - -	} 15
	{ Irish Plain - - -	
Old Red Sandstone - - -	Moorland and Plain - -	14
Ancient Rocks - - -	Moors and Mountains -	4-13
Igneous Rocks - - -	Moors and Mountains -	1-3

PART I.

LESSON I.

THE CONTINENTAL SHELF.

1. Examine Fig. 1, having your atlas open at the map of the British Isles. How many large islands are shown? What is the name of each? What are the chief small islands and groups of islands?

Study the explanation of the shading on Fig. 1.

The lines which form the boundaries between differently-shaded areas are **contour-lines**, that is, *lines every point on which is at the same height above or depth below sea-level.*

A map, having on it contour-lines, the areas between which are shaded or coloured on a definite plan to indicate height above sea-level, is called an **orographical map**. A similarly shaded map of the sea-bottom is called a **bathymetrical map**.

2. It is usual to express sea-depths in fathoms instead of feet. Taking a fathom as 6 feet, what are the depths, in fathoms, of the two submarine contour-lines in Fig. 1?

3. The area enclosed by the 100-fathom line (600 feet) is called the **Continental Shelf**. What part of the British Isles is nearest the edge of this shelf? Measure the distance. What is the distance of the edge of the shelf from (a) Land's End, (b) Valentia Island, (c) the Hebrides? In each case calculate the average slope or *gradient* of the sea-bottom in the following way:

$$\begin{aligned}\text{A fall of 600 feet in } x \text{ miles} &= \text{a gradient of } 1 \text{ in } \frac{5280x}{600} \\ &= 1 \text{ in } 8.8x.\end{aligned}$$

A reference to Fig. 2 will show a few examples of actual gradients. It is more convenient to express gradients by the formula 1 *in* x than by degrees and minutes. Gradient should always be measured in a direction at right angles to the contour-lines.





FIG. 1.—BATHY-MORPHOLOGICAL MAP OF THE BRITISH ISLES AND SEAS.

4. What part of the continent of Europe is separated from the British Isles by sea over 100 fathoms deep? What is the greatest breadth of this deep channel? What is its greatest distance from Great Britain?

5. Measure the distance between the 100 and 500 fathom lines where they are nearest together. Measure their distance apart along the lines already measured from Land's End, etc. Calculate the gradients thus:

A fall of 2400 feet in x miles

$$= \text{a gradient of } 1 \text{ in } \frac{5280x}{2400}$$

$$= 1 \text{ in } 2.2x.$$

What striking difference do you notice between these gradients and those previously obtained?

Bear in mind, with reference to all contour-lines, that *the land (or sea-bottom) on one side of a contour-line must be higher and that on the other side lower than the contour-line itself*. In other words, a contour-line is never an edge or crest, but always lies on a slope.

The direction in which the ground sinks is that in which you come, sooner or later, to a lower contour-line. Apply these rules to the following questions.

6. In a part of the North Sea additional contour-lines are drawn at 20 and 30 fathoms. They are omitted where they would closely follow the coast. The *Dogger Bank* is encircled by the 20 fathom line. Is its centre more or less than 20 fathoms deep? Are the *Silver Pits* more or less than 20 fathoms deep? Is

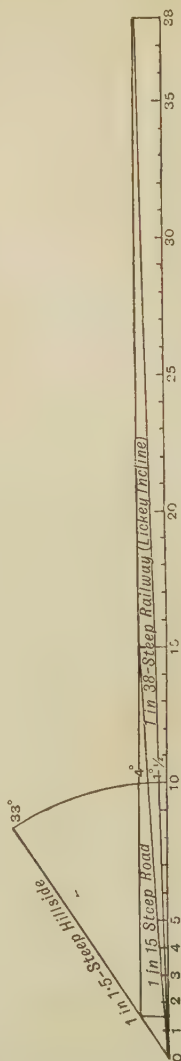


FIG. 2.—ILLUSTRATIONS OF GRADIENT.

The distance apart of the two horizontal lines is equal to one of the n-umbered divisions on the lower line.

the southern part of the North Sea shallower or deeper than the northern part? Measure the gradient from the north coast of Norfolk to the southern margin of the Silver Pits.

Islands.—The **British Isles** are a group of islands situated on the Atlantic border of Northern Europe. The sea around them for many miles is shallow, the bottom gradually sinking to a depth of about 100 fathoms (600 feet), beyond which it falls much more abruptly to depths of over 1000 fathoms, after which again the ocean-bottom is comparatively level. This steep slope may be considered from some points of view as the real edge of the continent; the shallow area with islands rising from it is called the **Continental Shelf**, and is a portion of the continent which the sea has invaded partly by eating away the land and partly owing to the land sinking (or the sea-level rising). The rocks of which the British Isles are composed show such similarity to those of the continent that it is impossible to resist the conclusion that the two were once continuous; the native plants and animals of the islands are the same as, though fewer in species than, those of the mainland. Thus, the British Isles are typical examples of **continental islands**, or islands formed by separation, in contrast with such islands as the coral-atolls and volcanic islands of the Pacific Ocean, which have never been part of a larger land and are termed **oceanic islands**.

The Dogger Bank.—Only one break occurs in the continuity of the Continental Shelf. A deep channel, the **Norway deep**, lies at a short distance from and parallel to the coast of Norway, attaining depths of 400 fathoms. The southern part of the North Sea is the shallowest part of the Continental Shelf, being nowhere more than 30 fathoms (180 feet) deep except in a narrow hollow known as the Silver Pits. The north-western part of this shallowest area forms the Dogger Bank, which rises to within 10 fathoms of the surface, and is ended on the north-west by a somewhat abrupt fall to over 40 fathoms. This shallow area is the feeding place of immense shoals of herring and other fish, and forms a great fishing-ground. That it was once dry land is shown by the

dredging from it of antlers of deer and the bones of deer, wolves, and other large animals, such as the mammoth and rhinoceros, that once inhabited this country.

The steepest slope at the edge of the Continental Shelf would not be too steep to run a road, or even a railway, straight up it, though for the latter the gradient would be severe. If the shelf itself were drained dry, the construction of railways across it would be extremely easy. None of the difficulties which mountainous or hilly districts afford on land would be met with. Although the Continental Shelf of Western Europe ends to the north-west, west, and south-west against the great depths of the Atlantic Ocean and the Bay of Biscay, there are two ridges that run out from its margin, and, though at first buried under more than 100 fathoms, presently rise to smaller depths than that. The more southerly of these, off the west coast of Ireland, is known as the **Porcupine Bank** (from the exploring vessel which first discovered its existence by sounding). The more northerly and more important is continued right across the North Atlantic as a broad area of comparatively shallow water, rising in parts above the surface as the **Faroe Islands, Iceland, and Greenland**. The narrow commencement of this area is called (after its discoverer) the **Wyville Thomson ridge**. The more distant parts of it, where the water is as shallow as over the Dogger Bank, constitute the important fishing-grounds of Iceland.

Between these two ridges lies the very deep area known as the **Rockall Deep**, and beyond it the little islet of **Rockall**, which forms the summit of an area of shallow water connected with the Continental Shelf by a very slight ridge.

LESSON II.

THE BRITISH ISLES.

1. Measure the greatest length and the greatest and least breadths of Great Britain and of Ireland. (This will be most easily done on the atlas.) Refer to the scale of miles and state the measurements in miles. Where is the distance least between Great Britain and the continent? Between Great Britain and Ireland? Measure these distances and state them in miles.

2. On which side of Great Britain is there most high ground? Where does the 600-foot contour-line lie farthest from the coast? At what distance is it? Determine the average gradient from it to the coast.

3. Measure the average inland gradient from the following places to the nearest point on the 600-foot contour: (i) Cromer; (ii) Grimsby; (iii) Newcastle; (iv) Peterhead; (v) Liverpool; (vi) Menai Strait. Can you find any place where the 600-foot contour-line comes right against the coast? What does this mean? Is there anything like it below sea-level?

4. Compare the extent of the area between 600 and 3000 feet above sea-level with the corresponding area below sea-level, as regards *breadth* and *shape*. How do the areas over 3000 feet above and below sea-level compare in extent?

5. Measure the steepest and the gentlest average gradients you can find between 600 and 3000 feet, in (i) the Grampian Highlands; (ii) North Wales; (iii) the Leinster Uplands.

6. Select from your results the gradients to fill the following table:

		Steepest Gradient Measured.	Gentlest Gradient Measured.
Submarine	{ between 0 and 600 feet, -		
	{ between 600 and 3000 feet, -		
Land	{ between 0 and 600 feet, -		
	{ between 600 and 3000 feet, -		

What general statement can you make as to the difference between submarine and land-gradients?

SUNRISE AND SUNSET IN THE BRITISH ISLES.

	GREENWICH.		PENZANCE.		EDINBURGH.		LERWICK.	
	Sunrise A.M.	Sunset P.M.	Sunrise A.M.	Sunset P.M.	Sunrise A.M.	Sunset P.M.	Sunrise A.M.	Sunset P.M.
March 21, -	6.2	6.12	6.25	6.33	6.15	6.23	6.7	6.15
June 21, - -	3.44	8.18	4.14	8.33	3.27	8.59	2.41	9.30
September 23,	5.48	5.46	6.10	6.18	6.0	6.8	5.52	6.0
December 22,	8.6	3.52	8.22	4.20	8.46	3.36	9.12	2.54

N.B.—Greenwich time is given in all cases.

7. Represent the above table graphically on squared paper ; space required—7 inches vertically by 4 inches horizontally. Take the middle horizontal line to represent noon, the intervals of a tenth of an inch above and below it representing 20 minutes each. Mark, at the left-hand end of the diagram, every third line with the sign of the hour it represents, as far up as 9 p.m. and down as 3 a.m. Take four vertical lines, an inch apart, to represent the four days of the year given above. On each of these mark with coloured pencil the time of sunrise and sunset at the four places given, using a different colour for each place.

Distinguish the effects of difference of (*a*) longitude and (*b*) latitude in determining differences in sunrise and sunset. The former is an unreal difference due to taking Greenwich time instead of local time, and is constant throughout the year (4 minutes of time for every degree of longitude). The latter is a real difference, being in the opposite direction for sunrise that it is for sunset, and varying from 0 at the Equinoxes to a maximum at the Solstices.

8. What is the length of day (from sunrise to sunset) in each of the places named—at Midsummer, at Christmas, and at the Equinoxes?

9. For how many hours must a motor-car riding by night near Edinburgh keep its lamps alight at Midsummer and Christmas-time respectively? (Lighting-up time is an hour after sunset ; extinguishing time is an hour before sunrise.)

The British Isles.—The islands which rise up from the Continental Shelf above the surface of the waters, with the exception of those small ones that lie close to the coast of the continent, are known as the British Isles. They are several thousand in number, but the great majority of them are very small. Two of them stand out among the rest by their far greater size—**Great Britain** and **Ireland**. One solitary island of over 100 square miles in area, and three groups of islands, in each of which there is at least one island of similar size, stand well apart from the main islands: these are the **Isle of Man** and the **Outer Hebrides, Orkneys** and **Shetlands**. A number of islands of the same order of magnitude lie close to the coast of Great Britain, separated from it by narrow channels only—**Skye, Mull, Jura, Islay** and **Arran** on the west coast of Scotland; **Anglesey** on the north coast of Wales; the **Isle of Wight** on the south coast of England. The remaining islands, whether occurring singly or in groups, are all much smaller; but some are still large enough to be inhabited and to yield a living to people who live on them without any absolute need for communication with the larger islands. Of these, **St. Kilda**, 40 miles west of the Outer Hebrides, is the most remote. Others are too small for this to be possible, but even among these the necessity of maintaining a lighthouse sometimes compels men to live on them, though they can only do so by means of supplies of food, clothing, fuel, etc., from the mainland.

Land-surface and sea-floor.—The bathy-orographical map (Fig. 1) shows that there is a certain similarity in the heights to which the land of the British Isles rises, and the depths to which the neighbouring sea-bottom sinks, above and below the sea-level respectively. In each case there is a considerable area less than 600 feet and a smaller area between 600 and 3000 feet above or below sea-level. There are also portions in each case extending to more than 3000 feet from sea-level; but here we find a profound difference, for in the case of the land these areas over 3000 feet in height are few and small, being mountain peaks and lofty plateaux, while the ocean-areas over 3000 feet in depth are very extensive hollows.

There is nothing magic in the line which marks 600 feet above or below sea-level, but experience has shown that it is a very convenient line to take as separating **shallow water** from **deep water** and **lowlands** from **uplands**. Below sea-level it marks approximately three changes: (1) the slope of the sea-bottom frequently becomes steeper from about this depth to some much greater depth, (2) it is about the greatest depth to which waves and currents can disturb the mud on the sea-bottom—hence it is sometimes called the **mud-line**—and (3) it is about the greatest depth to which sunlight can penetrate and at which any ordinary green or red seaweed can live. The physical differences between the sea-bottom above and below this level are therefore great.

On the land the physical differences are not so great, and no one standing just 600 feet above the sea would notice any sudden difference between the ground above and below him. Yet when we find any large area on the map lying mainly above this level, we may be sure that it differs in general from an equally large neighbouring area below that level by being on the whole colder, and less fertile; frequently also by being rainier, by having more rapid and less navigable streams, narrower and steeper-sided valleys and a less level surface, though there are exceptions to these latter conditions in certain parts of the world. A line drawn at 550 or 650 feet above the sea would serve as well as one at 600 to mark these differences, which do not come in abruptly; but the 600 feet contour-line is the most convenient boundary between the uplands and lowlands.

In Great Britain, as Fig. 1 shows, the high ground is mainly found to the west and north-west. Five masses of continuous high ground form the **Welsh Uplands**, the **Pennine Axis**, the **Southern Uplands of Scotland**, the **Grampian Highlands**, and the **North-Western Highlands**.

In Ireland and in the south-western peninsula of England we see scattered smaller masses of high ground. In the centre and south-east of England there are numerous hills that rise to about 600 feet, but in a great part of Ireland and the centre

and east of England, no hill reaches this height. We may, therefore, speak of these areas as the **Irish** and **English Plains**, remembering that the surface of a plain is not always a dead flat. In Scotland the area called the **Midland Valley**¹ is seen to be far hillier than these plains, and though sharply marked off from the unbroken mass of the Highlands to the north, is less clearly separable from the Southern Uplands. The Midland Valley and Southern Uplands are, therefore, together spoken of as the **Scottish Lowlands**, though the term lowland here has not quite its usual geographical sense.

LESSON III.

THE TIDES.

VARIATION OF HEIGHT OF WATER AT HULL DURING 24 HOURS
ON A PARTICULAR DAY.

Time.	Height of Water.	Time.	Height of Water.
^h 12.0 midnight	15 ft. 5 in.	^h 12.0 noon	15 ft. 7 in.
1.0 a.m.	11 ,, 8 ,,	1.0 p.m.	12 ,, 1 ,,
2.0 ,,	8 ,, 10 ,,	2.0 ,,	9 ,, 2 ,,
3.0 ,,	7 ,, 2 ,,	3.0 ,,	7 ,, 2 ,,
4.0 ,,	9 ,, 3 ,,	4.0 ,,	7 ,, 2 ,,
5.0 ,,	13 ,, 6 ,,	5.0 ,,	10 ,, 4 ,,
6.0 ,,	17 ,, 6 ,,	6.0 ,,	14 ,, 5 ,,
7.0 ,,	21 ,, 9 ,,	7.0 ,,	18 ,, 7 ,,
8.0 ,,	24 ,, 2 ,,	8.0 ,,	22 ,, 2 ,,
9.0 ,,	24 ,, 11 ,,	9.0 ,,	23 ,, 8 ,,
10.0 ,,	22 ,, 9 ,,	10.0 ,,	23 ,, 2 ,,
11.0 ,,	19 ,, 3 ,,	11.0 ,,	20 ,, 8 ,,

Fig. 3 was plotted from the hourly observations of the varying height of the sea-level recorded in the above table. The hours are marked at equal distances along the horizontal line, and above each a vertical measurement is

¹Marked as Lowlands on Fig. 1, but this term includes both the Midland Valley and the Southern Uplands.

taken proportional to the height of the water above a datum-level. Through the points so obtained a curve is drawn.

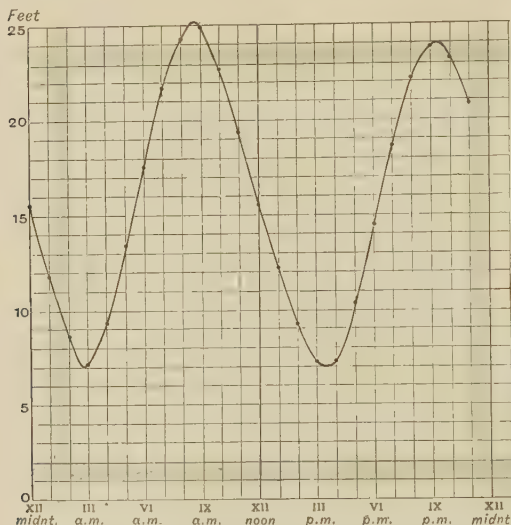


FIG. 3.—VARIATION OF HEIGHT OF WATER AT HULL DURING ONE DAY.

1. Was the water rising or falling when observations began at midnight? Was it rising or falling when they ended? Was the water then higher or lower than at first?

Judging from the course of the curve how many more hours would it be before the water next stood at its original height? By that time how many complete up-movements and down-movements would it have made? What is the average time of a complete double oscillation, *i.e.* for the water to return to its original height after being once to the highest and once to the lowest point?

2. Notice the top and bottom points of the curve; they have in no case been drawn exactly at the even hours. Why was this done? State, if you can, why the first low-tide is made in the diagram to come a little before 3 a.m., while the second is exactly at 3.30 p.m. Why is the first high-tide put *before* 9 a.m. and the second *after* 9 p.m.?

SPRING- AND NEAP-TIDES.

VARIATION OF THE HEIGHT OF HIGH WATER DURING A LUNAR MONTH. DEPTH OF WATER AT THE LONDON AND VICTORIA DOCKS.

Age of Moon.	High Water Mark.	Age of Moon.	High Water Mark.
0 (New)	28 ft. 6 in.	15 days (Full)	28 ft. 0 in.
1 day	28 „ 9 „	16 „	28 „ 6 „
2 days	28 „ 6 „	17 „	29 „ 0 „
3 „	28 „ 0 „	18 „	29 „ 0 „
4 „	27 „ 9 „	19 „	28 „ 9 „
5 „	27 „ 0 „	20 „	28 „ 3 „
6 „	26 „ 6 „	21 „	27 „ 6 „
7 „	25 „ 6 „	22 „ (Last Quar.)	26 „ 9 „
8 „ (First Quar.)	25 „ 0 „	23 „	26 „ 0 „
9 „	24 „ 9 „	24 „	26 „ 0 „
10 „	25 „ 0 „	25 „	26 „ 0 „
11 „	25 „ 6 „	26 „	26 „ 6 „
12 „	26 „ 0 „	27 „	27 „ 0 „
13 „	26 „ 9 „	28 „	27 „ 3 „
14 „	27 „ 3 „	29 „ (New)	27 „ 6 „

3. Plot the second table on squared paper in the form of a curve like Fig. 3, but make the horizontal measurements denote days and the vertical measurements the height of high water on each day. The highest high-tides are called *Spring-tides*, the lowest *Neap-tides*. How many of each occur in a lunar month? What is the relation of their dates and those of the moon's quarters?

Fig. 4 shows the hours of high water at different places on the same day. Thus, at whatever hour it is high-tide at Aberdeen, it is also high-tide at all places along the line marked I running south-east and east from Aberdeen. At places on the line marked XII, high-tide will be an hour earlier, and on the line marked II an hour later than at Aberdeen. The actual times change from day to day, but the differences of time remain the same. Such lines are called **co-tidal lines**.



FIG. 4.—CO-TIDAL LINES IN THE BRITISH SEAS.

4. Measure the distance in miles along the English Channel from the easternmost point of the co-tidal line iv to the easternmost point of xi. At what velocity does the tidal-wave advance up the Channel? A traveller sees high-tide at Plymouth, then takes an express train reaching London in 5 hours, and after waiting there an hour travels to Dover in 2 hours; will he be in time to see high-tide at Dover?

5. At what time does the tidal-wave, passing the Orkney Isles at 10 a.m., reach (a) Aberdeen, (b) Newcastle, (c) Yarmouth, (d) Harwich?

6. When it is high water at Liverpool is it high or low at (a) Cork, (b) Wick, (c) Plymouth, (d) Dover, (e) Belfast?

High and low water.—Everyone who has stayed at the seaside for a fortnight knows that the level of the sea rises and falls twice in a day; that the time of high water is later and later every day; and that the amount of rise and fall gradually changes as the hour of high water changes. The rising of the water is called the **flow of the tide**, the falling is the **ebb of the tide**. On a broad, sandy shore, such as is generally chosen for a holiday visit, the flow and ebb show themselves as an advance and retreat of the water ^{up} and down the gently-inclined plane of the sands. At a place on the Bristol Channel, for example, when high water is about 7 o'clock, morning and evening, the sea comes very high up on the shore, while at 1 o'clock it lies a very long way out. These very high flows and very low ebbs are known as **spring-tides**. Next day, high water would be somewhere about 8 o'clock, and it would not be so high; and so on, later and lower every day for a week, when the times of high and low water would be found to have changed places, and the rise and fall of the water would be very slight; these are **neap-tides**. During the next week, high-tide gets steadily higher as it gets later, until at the end of a fortnight we have the same times as at first and spring-tides again. So that there are not exactly 2 high-tides every day, but 27 in a fortnight.

By careful observation it is easy to discover that spring-tides always occur near the times of new moon and full moon; neap-

tides occur near the first quarter and third quarter. It is also easy to notice that the later time of tide each day corresponds to the later rising and setting of the moon. The rise of the waters or **tidal-wave** is in fact trying to follow the moon as it moves round the world,¹ but the continents obstruct it and cause it to turn in various directions. Thus, although the moon's apparent motion is, like the sun's, from east to west, the tidal-wave reaches the British Isles from the south-west from the Atlantic. As it passes into the shallow water of the Continental Shelf, and among the islands, it becomes slower, and the **amplitude** of the wave, or the vertical height from the trough to the crest, becomes greater. In the open ocean the difference between flood-level and ebb-level is only a foot or two; in some places in the British Isles it is 60 feet at spring-tides, and is not often less than 6 feet even at neap-tides.

Tides in the British Seas.—The tidal-wave is split into three parts by the two main islands constituting the British Isles. The first division, which travels most rapidly at first, keeps to the west of Ireland and Scotland and passes by the Pentland Firth into the North Sea, where it travels southward. The second passes up St. George's Channel into the Irish Sea. The third travels up the English Channel, through the Strait of Dover, and along the southern portion of the North Sea.

Fig. 4 shows the progress of these three waves, and the times of spring-tide high water at different parts of our coasts. Where any two waves meet again, some confusion may occur. In the north part of the Irish Sea, the first and second waves come together about the same time; and off the Kentish coast the first wave arrives twelve hours later than the third, that is to say, at the same time as the next wave from the English Channel. But in the North Sea, south of the Dogger Bank, there is a 6-hours' difference in the time these two waves are due; so that the crest (high-tide) of one meets the trough (low-tide) of the other, and consequently they neutralize one another, and there is practically no tide there.

¹To put it more accurately, the wave lags behind as the earth rotates on its axis.

Each of the three main waves subdivides when it encounters an island: the most interesting case is that of the Isle of Wight, which gives the port of Southampton four tides a day instead of two, the wave through Spithead arriving about two hours later than the one through the Solent.

The tidal-wave rushes up river mouths, impeding the river-flow, and sometimes forming a visible wave or **bore**. The finest example is on the Severn estuary, because this receives the tidal-wave in its full vigour direct from the Atlantic, and it is a deep funnel-like estuary. Here the tidal bore is a mass of water from one foot to two feet in height above the river-level (Figs. 49 and 50, pp. 134, 135).

LESSON IV.

BRITISH CLIMATE.

Isotherms are lines drawn on a map joining all points which have the same average temperature during a given period. In Figs. 5 and 7 the periods are the months of January and July respectively. The places on one side of an isotherm are, on the average, warmer; those on the other side, cooler.

1. Examine Fig. 7. Is Scotland cooler or warmer than England, on the average, during July? Find three places in the British Isles which are cooler in July than some other place due north of them. State whether the warmer or the cooler place is nearer the sea in each case. If you can, draw any inference as to the effect of the sea on summer temperature.

Follow the isotherm of 60° F. across the map: how does its course differ from a parallel of latitude? What is its course (a) inland, (b) near the sea? Do other isotherms follow similar courses? Does this behaviour confirm your previous inference?

Are places on the east coast of Great Britain warmer or cooler in summer than those on the same latitude on the west coast? What is the greatest number of degrees difference you can find? Does the same kind of difference hold for the Irish coasts?

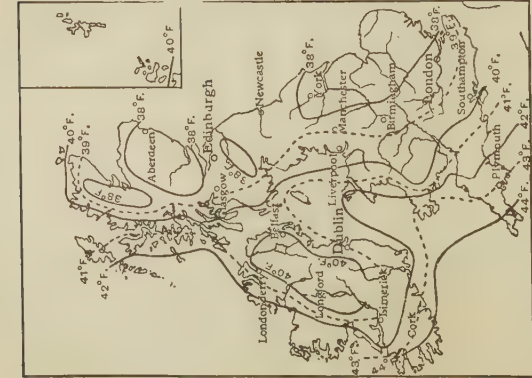


FIG. 5.—Isotherms of the British Isles for January.



FIG. 6.—Average Annual Range of Average Daily Temperature in the British Isles. (After Dickson.)

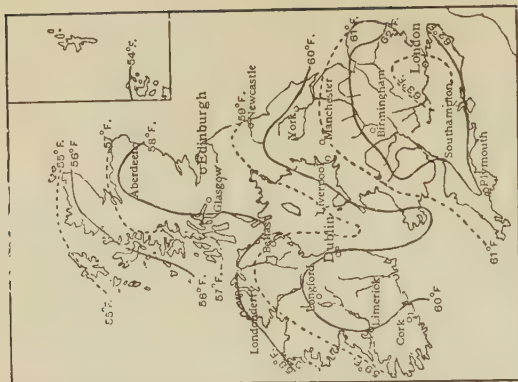


FIG. 7.—Isotherms of the British Isles for July.

2. Examine Fig. 5. Which are the coldest parts of the British Isles in January? Which are the warmest? In what general direction does the isotherm of 40° F. run? On which side of it is the average temperature higher, and on which, lower? How does the average January temperature of Cape Wrath compare with that of the Isle of Wight? How did the July temperatures compare?

What do you notice about the isotherm of 42° F. when it crosses the Irish Sea? What does this indicate as to the effect of the sea on temperature in winter? Compare this isotherm with the July isotherm of 60° F. Can you make a statement as to the influence of the sea on temperature that will cover both cases?

3. Fig. 6 shows the range of average daily temperature throughout the year, *i.e.* the difference between the highest and lowest average daily temperatures. Take a tracing of this map, and transfer it to a sheet of drawing paper. Shade very lightly in pencil the area having a range from 18° to 21° F.; more darkly that with a range from 21° to 24° F., and very darkly that with over 24° F. What is the annual range at London, Birmingham, Liverpool, Manchester, Glasgow, and Dublin respectively? Which area has the greatest range? Does this area show a low winter and high summer temperature in Figs. 5 and 7? How do inland places differ from places near the coast, as to range? How do the east and west coasts differ? Does this confirm your previous inferences as to the influence of the sea?

4. Fig. 8 shows the average amount of yearly *rainfall* in different parts of the British Isles. Compare it with Figs. 1 and 2: are the rainiest areas lofty or low? Do they lie near the eastern or the western coasts? Compare with Fig. 6. Does heavy rainfall coincide generally with a low or a high range of temperature?

In your own experience is wet weather in winter warmer or colder than dry weather? Which is it in summer? What influence does this point to rainfall having on temperature? Will this influence explain the differences you have already noted between the east and west coasts?

Fig. 9 is a **wind-rose** or diagrammatic representation of the relative frequency with which the wind blows from different quarters. It was constructed from the statistics



given for the Butt of Lewis in the subjoined table. Lines were drawn in the eight directions and a distance measured off each proportional to the percentage of observations in the corresponding direction (one millimetre for 1 per cent.).



FIG. 9.—Annual Wind-Rose for Butt of Lewis.

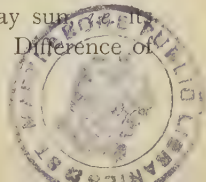
AVERAGE PERCENTAGES OF THE DIRECTION OF WIND DURING THE YEAR.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	Calm.
Butt of Lewis -	11	9	14	12	13	17	13	10	1
Aberdeen -	5	4	6	11	19	13	14	16	12
Glasgow -	3	15	13	4	9	18	15	3	20
Durham -	7	12	6	5	20	18	12	15	3
Dublin -	5	6	11	9	8	13	28	12	8
Valencia -	10	7	6	12	13	12	14	11	15
Cork -	15	9	9	7	10	14	21	13	2
Greenwich -	11	12	10	6	11	28	15	5	2
Marlborough -	6	7	7	2	6	16	14	5	37
Folkestone -	14	10	12	4	13	18	16	8	5
Falmouth -	10	6	9	7	11	15	18	16	8

5. Make a series of similar wind-roses for each of the places in the above table. Make a sketch-map of the British Isles and mark upon it the position of each of these eleven places. What general statement can you make as to the predominant directions of the wind in the British Isles?

Latitude and climate.—The British Isles extend through more than 10 degrees of latitude, that is, from fifty degrees north of the equator to sixty degrees north of the equator, and there is a decided difference between the Shetlands and Cornwall in respect of the length of daylight at midsummer and at Christmas, and in the altitude of the noonday sun height above the horizon throughout the year. Difference of

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latitude, however, is not the only cause of difference of **climate**. That it has an effect on temperature is seen in Fig. 7, which represents the summer **isotherms**, or lines of equal average temperature of the air. It will be seen that they run in a roughly east and west direction, so that on the whole the air gets steadily cooler from south to north. But there are marked irregularities in the summer isotherms: they tend to bend southwards near the sea and northwards inland, the seaside being cooler in summer than other places in the same latitude. This is the effect of the greater **specific heat** of water as compared with land (that is, water does not become hot so readily as land, or it requires more heat than land does to raise its temperature by a given number of degrees). A certain amount of heat is also absorbed by the evaporation from the large surface of the sea. During the hot sunny days, when the barometer stands high all over these islands with so little difference in the pressure from place to place that there is scarcely any general movement of the air, the temperature of the land and of the air over it rises much more quickly than that of the sea and its overlying air; difference of pressure is set up and a strong sea-breeze blows, cooling the land. Inland, where this does not happen, the land cannot cool down in the short nights as much as it is heated in the long days, and heat is stored up from day to day until rainy weather comes to cool the land.

If we turn to the map of winter isotherms (Fig. 5), we see a very different state of things. Latitude seems to have no influence on the temperature, as the isotherms run north and south, instead of east and west. On the map of a larger area it is seen that this course is part of a great northward bend over the Atlantic which makes the British Isles far milder in winter than most other places in the same latitude, and keeps the ports of western Europe free from ice when those of eastern America in the same latitude are frozen over. The greater part of this winter warmth is not due directly to the sun's rays, but to the heat stored up in the water-vapour that comes to our islands from more southerly latitudes and is liberated when the vapour falls as rain, giving rise to what

may be called **rain-warmth**. Why rain-warmth should be greater in the west than the east may be understood from a consideration of the rainfall-map (Fig. 8).

Rainfall.—The predominant winds in these islands are south-westerly and westerly, and these are also the rainiest. They come from over the broad Atlantic, bringing with them the water-vapour given off from an immense surface of water. On reaching the land, especially where there is a rapid rise in its surface, the air is forced to move upwards as well as forwards: it is consequently cooled by expansion and it is no longer able to hold all its water-vapour, and the excess falls as rain. When the air has crossed the hill-tops and descends on the other side it is warmed by compression, its capacity for holding water-vapour is increased and no more rain falls. In regions where the winds blow from the sea very steadily against an unbroken mountain-front, the leeward side of the mountains may be a rainless desert. Eastern Britain is saved from this fate by two circumstances—first, that the wind though most frequently south-westerly or westerly does at times blow from all other quarters; and secondly, that the mountainous regions of the west are broken by a number of lowland passages along which the wind can find its way towards the east with little loss of water-vapour. Still, the east is much drier than the west, as Fig. 8 shows.

LESSON V.

THE THAMES ESTUARY.

1. Examine Fig. 10. What is the scale of the map? What area in square miles does this map represent? Take a tracing on squared tracing paper of the inner frame of the map and the coast line, omitting the Thames estuary west of $0^{\circ} 30'$ E. longitude and other narrow estuaries; and count the number of squares occupied by sea (portions of squares larger than a half to be counted as whole squares, those smaller not to be counted at all). What area in square miles does this represent? How many square miles remain for the land?

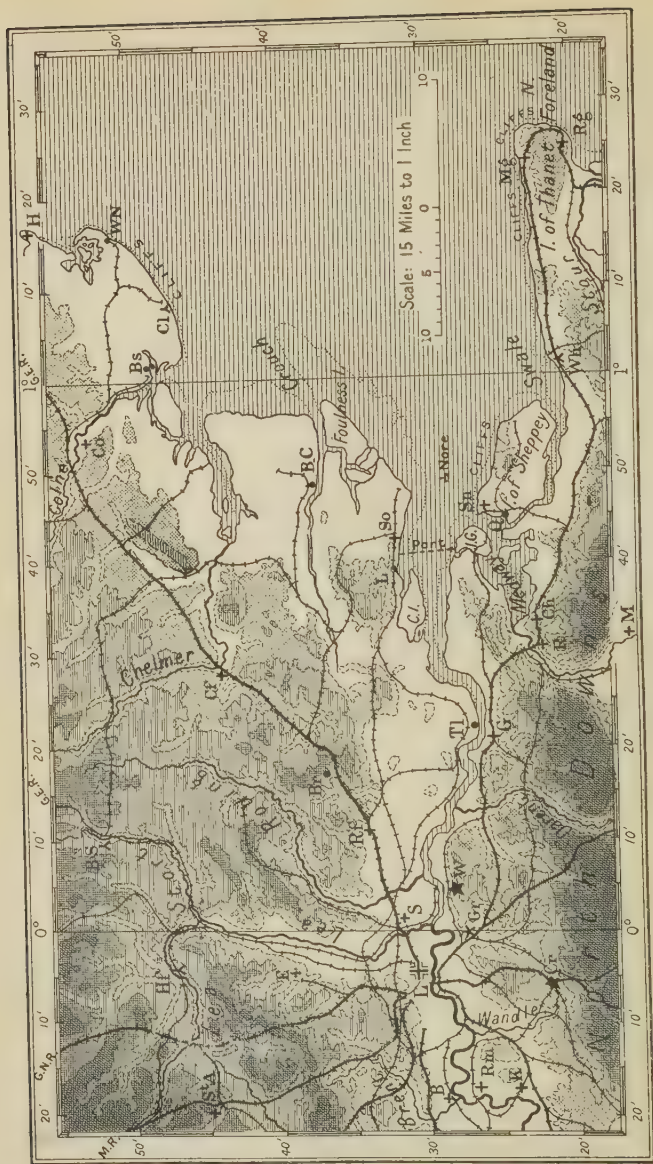


FIG. 10.—THE THAMES ESTUARY.

The contour-lines are drawn at 100, 200, 300 and 400 feet above sea-level. The dotted line is the low-water mark of spring tides.

2. Trace on the same paper the 100-foot contour-line (the line separating the blank area from the most lightly shaded area on the land). Measure the area of land less than 100 feet above sea-level. What percentage of the total land area on the map is this?

The figures in the margin of the map give the latitude and longitude in degrees and minutes: in the case of the latitude, 51° must be added to the minutes.

3. Measure the length of a degree (*a*) of longitude, (*b*) of latitude, on this map. From your results calculate the length of a minute (*a*) of longitude, (*b*) of latitude, to the nearest tenth of a mile. Write down the latitude and longitude (estimated to the nearest minute) of Greenwich (Gr.) St. Albans (St. A.), the city of London (L.), Bishops Stortford (B. S.), Colchester (Co.), Southend (So.), Chatham (Ch.), and Ramsgate (Rg.).

4. On which side of the Thames estuary does the land rise most rapidly? Measure the shortest distance on the north side from Tilbury (Tl.), (*a*) to the 300-foot contour, (*b*) to the 400-foot contour. Measure the corresponding distances southwards from Gravesend (G.).

5. Measure the distance (in miles) along the centre line of each of the following estuaries from the lowest point crossed by a bridge to its mouth (which may be taken as the point where the two sides of the estuary cease being nearly parallel and diverge rapidly).

ESTUARY.	LOWEST POINT BRIDGED.
Colne.	Colchester (Co.).
Blackwater (Chelmer).	Maldon (close to the railway).
Crouch.	Battlesbridge (close to the railway).
Thames.	London (L.).
Medway.	Rochester (R.).

6. If the land shown on the map in Fig. 10 were to sink 100 feet, or the sea-level to rise 100 feet, into what would the valleys of the Lea, Roding, Chelmer and Colne be changed? How many islands would be formed north of the present Thames estuary? What explanation do your conclusions suggest of the character of the actual coast-line, with its long sea-inlets and occasional islands?

East Coast estuaries.—An examination of the map of the British Isles shows that a vessel sailing up the English Channel to the North Sea, though it may find many good harbours to lie in, finds no river-estuary that will enable it to sail far into the land until it reaches the mouth of the **Thames**. Beyond the Thames (the **Wash** being shallow and the mouth of many small rivers instead of one large one) no similar estuary is found until the **Humber** is reached, and afterwards the **Forth** and the **Tay**.

In early times when carriage by water was much easier than by land (and even in these days of good roads and railways it has still the advantage of cheapness, though not of swiftness) it was a great thing for trading vessels to be able to penetrate to some inland point where trade could be done with the inhabitants of a larger area than at a place on the coast. Thus, from the dawn of history the estuary of the Thames has conveyed a great part of the trade of southern Britain, and it still keeps its position as one of the great ports of the world—the port of London.

The Port of London.—It is, of course, impossible to say exactly where the river Thames ends and the sea begins, but it is customary to take it as being at the point called the **Nore**, marked by a buoy and a lightship. On this definition the Medway is a tributary of the Thames. But there is another boundary, equally artificial, six miles above the Nore and therefore above the mouth of the Medway—the boundary of the Port of London. This is a line drawn north from Yantlet Creek. All goods landed or shipped above this line are reckoned in the trade of London, so that London as a port is a very different thing from London as a city. The tides, however, flow up the Thames far above London city. At the Nore, high water occurs about the time the moon crosses the meridian (*i.e.*, is due south), and the rise and fall averages 20 feet. At London Bridge high tide is 2 hours later, and the rise and fall is 13 feet at neap-tides and over 20 feet at spring-tides. How high up the Thames the tide would reach if left to itself we do not know. It is stopped by

a weir at Teddington, and here the average rise and fall is about 2 feet.

The view of the Essex coast from a Thames steamer impresses the traveller with the contrast between its bare, almost uninhabited character and the traffic from all parts of the world that floats past it. The map shows long stretches of coast without a town or village. This is because the land is low and marshy, only prevented from being flooded at high water by artificial embankments. Here and there for a few miles we find cliffs of no great height, and at these points are towns—Walton, Clacton, Southend and Westcliff. Elsewhere long narrow, marsh-bordered inlets, reaching for ten miles perhaps inland, are found, and it is generally at the head of these inlets that towns—Ipswich, Colchester, Maldon—have grown up. These inlets or creeks seem to denote that the land has sunk, as they have just the form that a river-valley flooded by the sea would show. Hence they may be termed **drowned valleys**. Sometimes the sea has submerged a low point between two adjacent valleys, cutting off an island (e.g. Mersea, Foulness and Canvey Islands).

The Kent coast is similar, but here the ground rises more rapidly towards the ridge of the North Downs than does that of Essex, and the cliffs along the coast are higher and continue for longer distances. Coast towns are therefore more numerous. Here, again, are found long narrow creeks, of which the Medway mouth, with Rochester and Chatham at its head, is the chief; and islands occur barely separated from the land, as Thanet (once an island, now reunited), Sheppey and the Isle of Grain.

Many of these creeks are the sites of valuable oyster beds: Whitstable on the south side and Colchester on the north are famous for oysters. The main roads and railways keep away from the coast, so that they can cross the rivers more easily. Colchester on one side and Rochester on the other show by their names that they were Roman fortresses (Latin *castra*, a fortified camp; modified to *chester*), where Roman roads crossed the Colne and Medway respectively. Alongside

Rochester is the modern Chatham, with its great naval dockyards, where battleships are built and where they can wait ready to protect the Thames from an enemy. From the piers of **Harwich** at the mouth of the Essex Stour, and of **Port Victoria** and **Queenborough** on the Medway estuary, steamers cross to Holland and Belgium. London travellers go by express train to and from the piers, and thus save the long boat journey along the Thames. Perishable goods traffic does the same, but mostly in the direction *to* London, as it is chiefly food for Londoners. Small ports of this kind which relieve a large river-port of the traffic that can least bear delay are called its **outports**; they are one of the results of the modern system of swift land-transport by rail.

LESSON VI.

LONDON.

1. Examine Fig. 11 and study the explanation of it. What is the width of the Thames at the western end of the map? At the eastern? In what parts of London is the course of the Thames due east? In which is it due north? due south? At what place on the south side does high ground come nearest to the river? What distance is the 25 feet contour from the river bank there? What distance is the same contour on the opposite side of the river? How much of this distance is over marshy ground? At how many places does the 25 feet contour come close to the river on the north side? Opposite which of these is the marshy ground on the south side narrowest?

If all this region were in a natural state, without any of the works of man, at which point would a traveller from Kent to Middlesex find the least difficult crossing—at Greenwich, or where London Bridge now is? What is the distance between these two points by river? How much higher than London Bridge must you go upstream to find no marshy ground on either side?

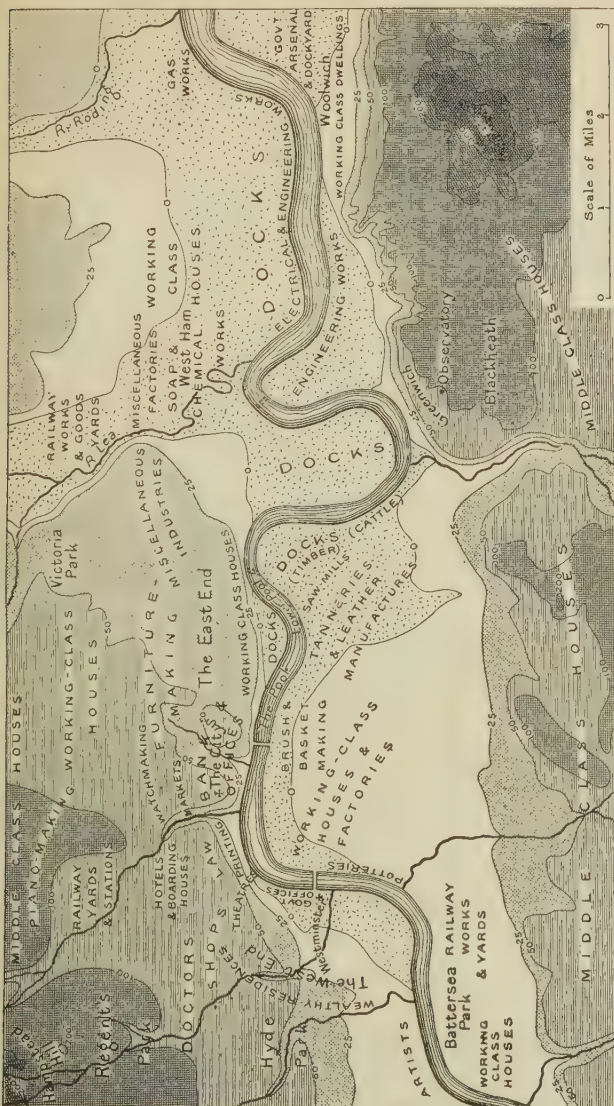


FIG. 11.—LONDON.

The dotted area alongside the river is that which, in the absence of artificial embanking, is marshy ground, liable to be flooded at high tide. The two bridges marked are London and Westminster bridges; the two tunnels, Blackwall and Rotherhithe; the two crosses mark St. Paul's Cathedral and Westminster Abbey. (The first-named of each two is the more easterly).

AREA AND POPULATION.

	Acres.	POPULATION.	
		1911 (1000).	1921 (1000).
Central London ¹ - -	7,465	746	682
London, Middle Ring ²	67,395	3,775	3,801
London, Outer Ring ³ -	368,599	2,730	2,993
England and Wales -	37,340,338	36,070	37,885

	IMPORTS, 1906.	EXPORTS, 1906.
	£1,000	£1,000
Food, Drink, and Tobacco - - -	76,715	5,505
Raw Materials - - - - -	59,111	2,367
Manufactured Goods - - - -	57,247	53,869
Miscellaneous - - - - -	6,334	7,890

2. Examine the table of *Area* and *Population*, and for each of the areas named find (a) the density of population in 1921, i.e. the number of persons to an acre; (b) the rate of increase or decrease of population during the period 1911-1921.

To determine this, if m be the population in 1911, and n that in 1921, the percentage rate of increase is $\frac{(n-m) \times 100}{m}$. If the amount is negative, it is a rate of decrease.

Represent the density of population in the three zones by dots arranged evenly on an inch square, after the model of Fig. 12.

To arrange a number of dots evenly in a square, express the number as $ab \pm c$, where a and b are as nearly equal as possible, and c as small as possible:

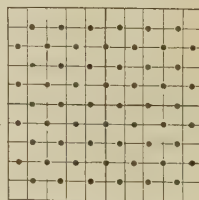


FIG. 12.—Density of Population in London's Middle Ring (58 per acre).

¹ The City, Westminster, Holborn, Finsbury, Shoreditch, Southwark, and Bermondsey.

² The rest of the administrative county of London.

³ Including all Middlesex, and parts of Surrey, Kent, Essex, and Hertfordshire.

the easiest case is, of course, where the number is an exact square. Thus, in Fig. 12, $58 = 8 \times 8 - 6$ or $9 \times 7 - 5$. The latter formula is preferred because there are nine horizontal lines; by placing 7 dots on 4 of these lines and 6 on the remainder, 58 dots are arranged sufficiently evenly.

3. Fig. 13 represents the proportions of the chief classes of *exports* by sectors of a circle. Instead of calculating percentages, the proportions are calculated to a 360 basis, and the nearest whole number of degrees is measured off in each case by a



FIG. 13.—Diagram of the proportions of the different exports of London.

protractor. Make a similar diagram for the *imports*, making the area of the circle proportionately larger. As the value of imports is about three times that of exports, the radius of the circle should be about 1.4 inch.

4. Study the table of imports (p. 32). State the five principal imports. Of what classes of imports does London import more than half the total of the United Kingdom? Of what commodity may London be said to have practically a monopoly of the import? What percentage of the goods of all kinds imported are re-exported again? What are the most important items of export? Of what classes of exports does London take more than half the total of the United Kingdom?

Of what commodity has London almost a monopoly of the export? Is London mainly an importing or an exporting port?

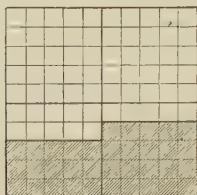


FIG. 14.—London's Share of the Total Imports of Butter and Cheese.

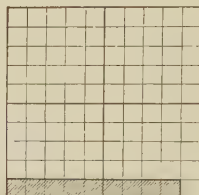


FIG. 15.—London's Share of the Total Exports of Cotton Goods.

Represent by diagrams like Fig. 14 London's share of the total *imports* of corn, etc., tea, coffee, and wine, and *exports* of woollen goods, machinery, chemicals, arms, books, and medicines.

PORT OF LONDON—IMPORTS AND EXPORTS, 1906.

FOOD, DRINK, AND TOBACCO.

IMPORTS.			EXPORTS.		
	Value.	Percentage of United Kingdom.		Value.	Percentage of United Kingdom.
	£1,000			£1,000	
Corn, Flour, etc. -	15,464	22.8	Provisions of British Manufacture -	5,505	26.1
Meat - - -	12,195	29.6	Tea, Coffee, and other Food Materials Re-exported	6,214	51.6
Butter and Cheese -	10,978	35.3			
Tea - - -	9,672	97.6			
Sugar - - -	5,850	31.6			
Fruits - - -	5,617	38.4			
Cattle, etc. - -	3,543	35.8			
Eggs - - -	2,081	29.3			
Wine - - -	1,899	45.1			
Coffee - - -	1,502	74.2			
Tobacco - - -	1,010	21.4			
Other Food Materials - -	6,903	25.1			

RAW MATERIALS.

IMPORTS.			EXPORTS.		
	Value.	Percentage of United Kingdom.		Value.	Percentage of United Kingdom.
	£1,000			£1,000	
Wool, - - -	18,363	55.1	British Raw Materials - - -	2,367	5.5
Jute and Hemp - -	6,420	51.3	Re-exported Raw Materials - -	22,062	46.5
Wood - - -	6,029	21.9			
Skins - - -	5,411	64.5			
Oils (including Petroleum) - -	4,584	38.1			
Rubber, etc. - -	3,365	82.0			
Seeds - - -	2,509	27.1			
Metal Ores - -	1,825	11.5			
Tallow, etc. - -	1,607	57.5			
Cotton - - -	1,306	2.3			
Other Raw Materials	7,692	28.0			

MANUFACTURED GOODS.

Metals - - -	17,258	41.3	Cotton Goods -	8,629	9.4
Leather and Leather Goods - - -	6,775	53.4	Woollen Goods -	5,651	27.5
Silk, Cotton, and Woollen Goods -	8,693	27.1	Metals - - -	7,002	14.0
Chemicals, etc. -	3,296	39.2	Machinery - -	3,855	14.4
Glass Goods - -	1,213	37.1	Apparel - - -	2,433	45.3
Paper, etc. - -	2,575	44.9	Arms and Ammunition - - -	2,087	63.1
Other Goods - -	14,236	31.2	Chemicals - -	1,816	23.0
Motor Cars, etc. -	2,241	45.2	Painter's Colours -	1,325	54.5
			Telegraph Wires -	1,303	89.7
			Leather Goods -	1,165	42.2
			Printed Books -	1,053	51.9
			Paper - - -	1,031	49.9
			Medicines - -	1,180	76.2
			Other Goods -	16,323	17.8
			Re-exported Manufactured Goods -	13,080	51.4

TOTALS.

£199,407	32.8	British Goods -	69,632	18.5
		Re-exports -	45,722	53.7
		Total -	£115,354	25.0

The lower Thames.—Up stream from the Nore, the river Thames narrows to about half a mile in width, and meanders in a series of loops (Fig. 10). The straighter parts of these loops are called **reaches**, and each has its name. There is still much marshland on either bank, but the higher ground comes nearer, and presently, at the northern or southern end of the loops, the river generally abuts upon it. Here landing-places can be found from which it is possible to travel inland without having to wade through the marshes, and here little towns have long ago grown up. The first of these is **Gravesend**, on the south side, where incoming vessels take on the pilot and custom-house officers, and those outward bound pick up late passengers. At Grays and Purfleet on the north, Greenhithe and Erith on the south, are great chalk-quarries, and here (as also on the Medway near Rochester) are made from the chalk immense quantities of whiting, lime, and Portland cement (Thames mud and lime being the constituents of the last named).

At **Greenwich** is the Observatory from which the world takes its longitudes and standard times. Nearer London the shores get much busier, for even the marshland can be turned to account for the excavation of docks, which require less digging where the surface is low to start with. The first of the docks met with are at **Tilbury**, just opposite Gravesend; but the most important and numerous are on the north side of the river, opposite Greenwich and **Woolwich**, and on the south side a little higher up stream. Great engineering works have also been established on the edge of the marshes, and the greatest of these is the Government Arsenal at Woolwich, where guns, great and small, shot and shell, and other army materials of all kinds are made (Fig. 11).

The site of London.—London is not yet reached, though it is near, and it is now time to ask why the city came to be so high up the river. The answer is that not until London itself is reached is high ground found near *both* sides of the river. Gravesend and the other small towns lower down have broad stretches of marsh facing them on the opposite shore. Even the city of London, though on a hill on the water's edge,

has the marshland of Bermondsey opposite it; but here at least the ground soon rises to the south, and travellers from Kent to the centre of England found this the first place where they could conveniently cross the Thames. The Romans carried a road across here, and built the first London Bridge. At the bridge, sea-vessels were obliged to stop, and here they could land their goods and trade with the people from both sides of the river as well as those who came down stream in smaller boats. So a great trading city grew up here in Roman times, and remains to this day.

At present the **City** is chiefly a place of banks and offices. The docks import great quantities of tea, wine, wool, timber (Surrey Docks), cattle (Deptford), and meat; but London is too far from the great manufacturing districts to be equally great in exports, and nearly half its exports are re-exports of goods already imported. A port which thus receives and temporarily stores goods on their way from one foreign land to another is called an **entrepot**.

About two miles higher up the river from London Bridge there was on the west side a little island in the marshes called Thorney. Here from its convenient position near the trading city of London was built a royal palace, which eventually became the home of Parliament, the great Government offices, and, until recent years, the Law Courts. Around this double centre—the **City** (as the original London is now generally called) and **Westminster**—has grown up the huge modern London.

The business of London.—To its original character of a trading port it has added that of a great manufacturing town, through having at hand a large supply of raw material. It is chiefly to the east of the city, near the docks and wharves, that factories are to be found. The West End, as the surroundings of Westminster are called, is the home of the wealthy, and of the professions (lawyers, doctors, architects, etc.), who naturally cluster round the centre of government. Being thus the home of those that have leisure and those who work with their brains, London has naturally become a great printing and publishing centre, and in the district between the City and Westminster,

the great business of producing books and newspapers is largely carried on. London is also the home of a great University, with many colleges, and of the National Art Galleries and Museums.

The difficulties of London.—The manufactures that naturally grew up in London were those that required the raw materials imported at the docks, and those that directly supplied the wants of the great population—and especially of the greatest accumulation of rich persons in the land. Of the former the most important are furniture making, tanning and leather manufactures; of the latter, watchmaking, jewellery, book and stationery making. But for the last century London industries have been struggling against great difficulties. On the one hand, the long distances from which coal and iron have to be brought handicap them in competition with places on the coalfields; and on the other they have to struggle for room in London against the banks and offices which can afford to pay much higher rents. Hence many industries have left London or are leaving it, either for the coalfields, where coal and iron are cheap, or for the open country where space is cheap. Ship-building has almost completely left the Thames; and in the case of many other industries, the earlier processes of manufacture, which often require much space, are more and more being taken away from London, which tends to become a “fitting and repairing shop, warehouse and showroom,” for the carrying out of such processes as need to be done close to the purchaser. Some idea is given on Fig. 11 of the areas where particular industries are located, but others of equal importance are too much scattered over London to be marked on the map.

The central districts are given over to offices, shops and warehouses, and are almost deserted at night, those who work in them sleeping often miles away. The conveyance to and fro of this great number of people, as well as those who come up to town from the country, and those who must travel from one part of London to another in the course of their business, is a work of great difficulty. The principal streets are always crowded except at night-time, in spite of the electric railways, which now carry passengers swiftly underground.

A special difficulty arises from the need of communication across the river. West of London Bridge there are now 13 road-bridges and 6 railway-bridges within the County of London. East of London Bridge the river must be kept open for large vessels; the only bridge (the Tower Bridge) is, therefore, a drawbridge, the carriage-way being closed to traffic and lifted when large vessels have to pass: a high-level footway far above the tops of the masts can then be used by foot-passengers. Elsewhere the river can be crossed by ferry or by tunnels, of which there are two for carriage-traffic, and one for foot-passengers. Railways tunnel under the Thames both east and west of London Bridge.

LESSON VII.

THE LONDON BASIN.

Fig. 16 represents by different kinds of shading the different rock-formations that form the *sub-soil* of the



FIG. 16.—GEOLOGICAL MAP OF THE LONDON BASIN.

district around London, *i.e.* that would be found by digging a few feet down at the most.

1. To what part of the area is the "alluvium" confined? Where is the largest area of Bagshot Sands found? Where in London do patches of Bagshot Sands occur? What formation is always found surrounding every area of Bagshot Sands? What always comes between this formation and the Chalk? In what parts of the map is Chalk shown?

2. Fig. 17 shows what rock-formations have been proved to exist underground at certain points in the district. Find these five places on the map, and see whether in each case the topmost formation shown in the boring is the one shown at

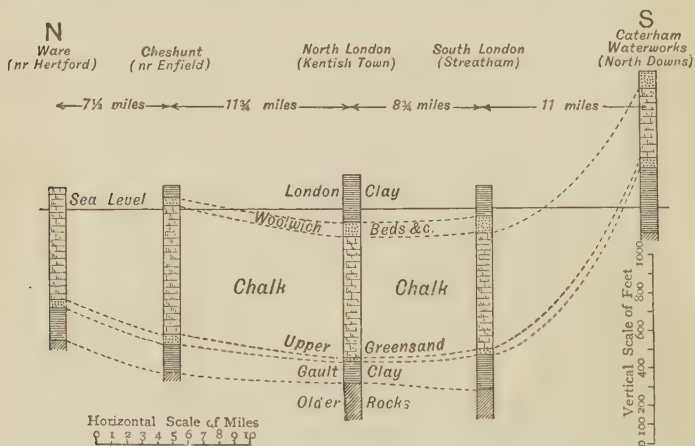


FIG. 17.—DEEP BORINGS IN THE NEIGHBOURHOOD OF LONDON.

that place on the map. What formation always comes under the London Clay in these borings? What comes under that? Does this order of sequence correspond with their positions on the map?

3. At what height above sea-level is the bottom of the Chalk on the North Downs (Caterham)? How much below sea-level is it under North London? Find the *real* gradient of the bottom of the Chalk between these points, by means of the vertical and horizontal scales given in Fig. 17. Find the corresponding gradient between North London and Ware. How much farther north would this gradient require you to go before the Chalk reached the same altitude as on the North

Downs? Measure the distances from the Thames at Richmond to the extreme limit of the Chalk—(a) northwestward to Wendover, (b) southward to Dorking. Does the difference between the two measurements correspond to the difference in the gradients on the two sides of the Thames valley?

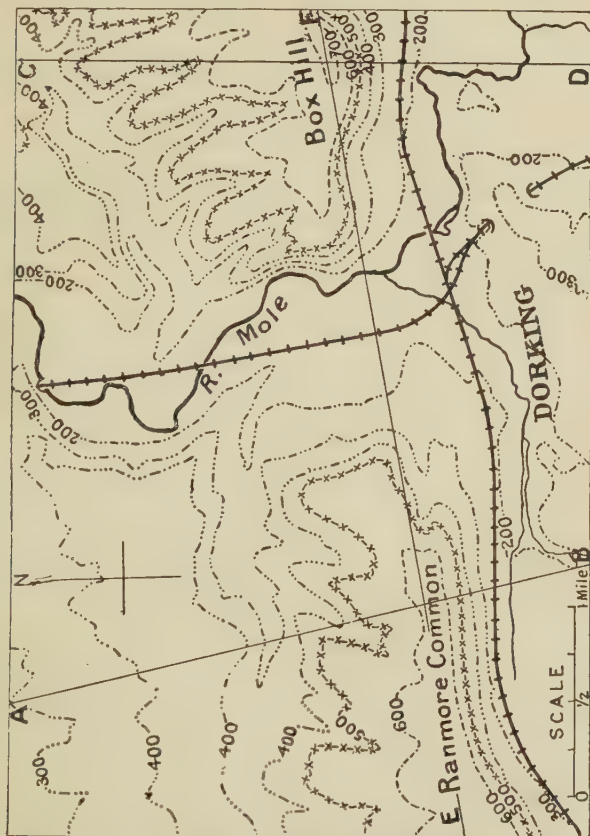


FIG. 18.—MAP OF PART OF THE NORTH DOWNS.

Outdoor work. Avail yourself of half-holidays if you live in London, and visit places near London where different formations come to the surface. Examine their characters so far as you can.

4. Fig. 18 is a large scale map (1 inch to a mile) of a part of the North Downs, with contour-lines at intervals of 100 feet. Examine carefully the form of the ground about Ranmore Common. What is the height of the common? On which side of it are the contour-lines straightest? On which side are they closest together? Measure the gradient along the line AB southwards from Ranmore Common, from the 600 to the 300 contour-line. Measure the average gradient for the first $\frac{3}{4}$ mile in the opposite direction.

5. If you were standing at E, in which direction would you expect to get the best view? In which direction would a group of trees half a mile away most obstruct the view of things beyond? In which direction would they least obstruct? From what other place shown on this map would you expect to get a finer view than from Ranmore Common? In which directions would the best views be had there?

6. A steep slope with fairly straight contour-lines is called an *escarpment*. Where are escarpments shown in this map? What separates these escarpments from one another? Refer to Fig. 16. What rock-formation comes to the surface in the North Downs? There are large quarries half a mile north of the D of 'Dorking'; what material is quarried there?

7. Construct a *section* to true scale along AB, as follows:

On a sheet of drawing-paper draw a horizontal line 12 inches long to represent sea-level. This is called the *base-line*. Take a straight-edged strip of paper more than 3 inches long and lay the edge along AB. Mark off on it every point where a contour-line crosses AB and note against each mark its altitude. Transfer these measurements to the base-line, but multiply each one by four so as to make the scale 4 inches to a mile. To avoid the danger of cumulative error, take the measurement for each point from A, not from the previous point. Erect perpendiculars about an inch high from each of the 15 points from A to B inclusive.

To make a vertical scale reading to hundreds of feet. This must be the same as the horizontal scale, 4 inches = 1 mile = 5280 feet, or 1 inch = 1320 feet, or $\frac{5}{8}$ in. = 1100 feet. On the perpendicular erected at one end of the base-line measure off $\frac{5}{8}$ inch and divide this into eleven equal parts. You will then have a scale of hundreds of

feet. From this scale mark off by means of the T-square the appropriate height on each perpendicular. Join the points so obtained by lightly ruled straight lines in the first place; this gives a profile which must be gone over and modified by freehand, so as to avoid sudden changes of gradient. Bear in mind that when two successive contour-lines are of the same altitude the ground between them must be either higher or lower according as it is lower or higher on the other side of the contour-line.

Where the line of section crosses a river, the surface-line must fall to the river and rise on the other side. An approximate idea of the level of the river may be obtained by measuring along it in each direction until the next contour-line in either direction is reached. For example, if the river crosses the 300 contour 5 miles above the line of section and the 200 line 3 miles below, the altitude at the section would be about $200 + \frac{3}{5}$ of $100 = 237\frac{1}{2}$ or, say, 240.

Draw similar sections along **CD** and **EF**. Notice the character of the escarpment in the cases of **AB** and **CD**.

The rocks beneath London.—The water-supply of a huge population like that of London is a very important matter. The local springs and wells that supplied it when a small place have long proved insufficient; and they are, moreover, liable to pollution. A great deal of London's water is taken from the Thames at Staines, filtered and stored in reservoirs, and distributed by pipes. But another important supply is from **artesian wells**, that is to say, deep borings underground into water-bearing layers of rock. These borings teach us the nature of the rock-layers under London (Fig. 17).

The water is pumped up from a great layer of **Chalk**, about 800 feet thick, which underlies London and its surrounding country. Beneath this chalk is a layer of clay, the **Gault**, which prevents the water from sinking down lower. Two borings have gone below this clay, but it is unnecessary here to describe what lies beneath. Above the chalk lie comparatively thin layers of sand, clay, and pebbles, and upon these rests a mass of clay, about 200 feet thick, called the

London clay. This clay prevents surface water from reaching the chalk, so that the water in the chalk must come from somewhere else.

The chalk rim.—A glance at the geological map of England shows a large area coloured brown where the London clay forms the subsoil (below the surface-soil). Around this, on the north-west and south, runs a band coloured green, representing the chalk country. This chalk country rises much higher than London, including ranges of hills over 600 feet above the sea—the North Downs, Berkshire Downs and Chilterns. It is the rain that falls on these hills which sinks into the chalk and makes its way under London to supply the artesian wells.

The way the chalk-layer is bent up on either side of London into these hills is shown in Fig. 19, which represents what



FIG. 19.—SECTION ACROSS THE LONDON BASIN (H. B. Woodward).
Alluvium and gravel not shown. 10, Bagshot Sands; 9, London Clay; 8, Woolwich and Reading beds; 7, Chalk; 6, Upper Greensand; 5, Gault; 4, Lower Greensand; 3, Weald Clay; 2, Wealden Sandstones; 1, Oxford Clay.

would be seen if a great slice, or **section**, could be cut across the land; only, to make it clearer, the measurements in the vertical direction are exaggerated compared with those in a horizontal direction. Otherwise, the London clay and chalk would have to be made so thin that they could hardly be seen; or else the length of the illustration would be too great to get into the page of this book.

As the London clay lies in a sort of hollow in the chalk, the area where it occurs is spoken of as the **London basin**, though the outline is rather too angular for that name to be quite appropriate. It is really only part of a basin, the other end of which is to be found in Belgium, the middle part being hidden by the North Sea.

Beds above the chalk.—All the rock-layers (or geological formations) overlying the chalk are collectively called the

tertiary beds. Of these, the London clay is the principal, but there are others. Beds of clay, sand, and pebbles are found underneath it, and these come up to the surface at Woolwich and elsewhere south of London, and also at Reading and other places in the west: so they are called the **Woolwich and Reading beds**. There are also other layers on top of the London Clay in many places. About London itself, for instance, the top layer immediately under the surface is often a gravel. But the largest area covered by another formation than the clay lies to the south-west, between the valleys of the Wey and the Loddon. Here stands a high area of very sandy ground, unsuitable in general for cultivation, and occupied by heaths and pine woods. The largest heath is known as **Bagshot Heath**, and the sands which underlie this area are called the **Bagshot sands** (Fig. 16). Such barren ground is valuable as an exercising ground for the Army, which can manoeuvre upon it freely without the damage that it would cause among cornfields and meadows. Here is situated the great army town of **Aldershot**, within easy reach by railway of Southampton, if troops are wanted for foreign service. The northern part of this sandy tract is **Windsor Forest**, once a hunting ground of the English kings; and at the northern end of this forest, on an eminence overlooking the Thames, stands the ancient fortress Windsor Castle, now retained as a royal palace on account of its convenient nearness to London.

Besides this main area of Bagshot sands there are a number of smaller areas of similar character, such as Hampstead Heath (Fig. 16). The pebbly beds of the Woolwich series also form poor soil for cultivation, and in a large area south-east of London, between Greenwich and Bromley (Gr. and By., Fig. 20) they support a number of heaths and commons, of which Blackheath is the chief. In the days before railways, these heathy areas were wild and thinly-populated, and, where the main roads crossed them, the haunts of highwaymen. Now, being within easy access of London and having a dry and healthy subsoil, they are favourite residential places and the open heaths are holiday resorts.

LESSON VIII.

THE THAMES BASIN.

1. Examine Fig. 20. What is the scale of the map? Measure the length and breadth of the map in miles. Place a piece of squared tracing paper over Fig. 20, and trace the thick black watershed-line, joining its end by a line following the coast and port boundary. Determine the area of the basin by counting squares.

2. Transfer these lines to the centre of an oblong piece of brown paper or thin card, not less than 10 inches by 6 inches, and cut out all the part enclosed within the line. In cutting, remember that it is the outside frame, not the centre-piece, which is to be kept. As perfect accuracy is impossible, it is better to cut away a little more than a little less. Fit this brown paper on the geological map so as to show only the geology of the Thames basin. As a guide to correct placing, see that Stroud and Tetbury are hidden in the west and Cirencester exposed; Devizes, Andover and Horsham hidden on the south, and Basingstoke and Guildford exposed. When correctly placed, keep the brown paper down with drawing-pins or a weight. Compare the geological map thus framed with Fig. 20.

A brown-paper or card frame thus prepared to hide all but a special portion of a map will be referred to in this book as a *mask*.

3. Make a sketch-map of the Thames basin. How many belts of high ground cross it? Mark these by shading. Indicate which of them are composed of chalk. Indicate the area of the London basin. Mark the highest point on the Chalk ridge bounding the London basin on the north-west. Is this on the watershed (p. 47) of the Thames basin or not? Mark the lowest points on the watershed between the Chalk ridge and the Oolite ridge.

The area between these two ridges may be called the *Oxford clay plain*; do any parts of it rise over 500 feet above the sea? Are these parts on or near the main watershed?

4. Make a sketch-map of the part of the Oolite ridge shown on Fig. 20. Mark the gaps in it less than 500 feet above the

sea. Indicate which of these are made use of for railways. How many railways cross the ridge where it is over 500 feet? How do the majority of these cross it?

5. Make a sketch-map of the North Downs. Include the Hog's Back, a part not rising above 500 feet. Mark the position of Box Hill and Ranmore Common (Fig. 18). Mark each of the **gaps** in the Downs, less than 500 feet high, and indicate which of these are dry (*wind-gaps*), and which are occupied by rivers (*water-gaps*). What difference do you notice between the form of the 500-foot contour-line on the north and south sides of the North Downs? With what other difference have you learned to associate this?

6. Make a sketch-map of the chalk ridge on the north side of the London basin. Judging from the contour-line, in which direction does its escarpment face? What river valley divides this ridge? Mark the western part, "Berkshire Downs," and the eastern, "Chiltern Hills." Mark any water-gaps and wind-gaps in both these.

Note the case of Wendover (Wd.): two V-shaped indentations of the 500 contour-line from opposite sides nearly meet one another here, there being a wind-gap at a little above 500 feet altitude. Find some nearly similar cases.

Thames and Tributaries.—It was learnt in Lesson V. that the tidal-wave of mixed salt and fresh water sweeps to and fro along the Thames up to Teddington. Beyond the tidal limit the volume of water flowing is much less, but is still very great, and it is now necessary to learn whence it all comes. As water flowing over the land can flow downhill only, it must all have come from higher ground, and as the Thames is followed up stream its surface-level slowly rises, until at a point between Marlow and Henley, 62 miles from London Bridge, it crosses the 100-foot contour-line. Within this distance a number of important tributaries have entered it (Fig. 20), so that its volume of water is perceptibly less than at Teddington, but still great. These tributaries all enter the river approximately at right angles, and are much smaller in volume than the main river.

In the **Kenet** a new kind of tributary is met, one which more

nearly equals in volume the main river itself, and forms a much more direct continuation of the direction of the lower Thames than does the upper Thames. Moreover, a glance at the geological map will show that the Kennet keeps along the same geological formations as the lower Thames, while the upper Thames and its tributaries do not. In fact, the Kennet flows along the middle line of the London basin, while the upper Thames enters that basin from beyond.

Watersheds.—As has been seen, the chalk that underlies London rises up into a line of hills beyond the edge of the London basin. Nearly all the northern tributaries of the lower Thames rise in these chalk hills (**The Chiltern Hills**), but the upper Thames and its tributaries come from beyond them. Thus, standing on the crest of the Chilterns and looking away from London, to the north-west, the streams in the plain in front flow to the upper Thames, those behind, to the lower Thames. The Chiltern Hills thus form a **water-parting** or **watershed** between the two sets of streams; but as they both finally reach the same river, it is only a minor or **secondary**, not a main or **primary watershed**. In the same way the Berkshire Downs form the secondary watershed between the upper Thames and Kennet.

In both cases, the slope from the crest of the hills to the north or north-west is very steep and falls to a broad river valley, while in the opposite direction the general slope is gentle and furrowed by a number of valleys, some occupied by streams, others dry. The steep slope is called the **escarpment** of the chalk, which here comes to an abrupt end.

The upper Thames, traced upstream, is soon divided into a number of tributaries of about equal importance (**Isis, Evenlode, Cherwell**—the first of these is taken as the main Thames).

The Thames crosses the 200-foot contour-line a few miles above Oxford, about 57 miles above the 100-foot crossing, so that the **gradient** or **degree of slope** of its bed is a little more rapid here than in the lower Thames; but by measuring up the Kennet, the 200 level is reached in about 25 miles; beyond, the rise is from 200 to 300 in about 14 miles, 300 to 400 in

about 11 miles, 400 to 500 in 9 miles, and 500 to 600 in 6 miles. This shows that the slope or gradient of the stream becomes greater as its source is approached. Most rivers show the same character, if there are neither lakes nor waterfalls on their course. The main Thames rises at less than 400 feet above the sea, and therefore does not illustrate this feature quite so strikingly.

Whatever branch is followed, it is found that the farther it is traced the smaller it becomes, as tributary after tributary is left to its own course. The **source**—a spring on a hillside—is reached at last. In wet weather the rain that falls higher up the hill will form a temporary stream swelling its course; but higher still a point is reached where the rain will flow down the other side of the hill, to enter other streams and reach the sea by some other river—the Severn, Ouse, or Avon. Here, then, is found the main **water-parting** or **watershed** of the Thames, and it can be followed as a continuous line enclosing an area within which every drop of rain that falls and does not dry up flows into the Thames—this area is the **Thames basin**. It is a very awkwardly-shaped “basin,” and its rim (the watershed) is very uneven. By referring to the map it is seen that the rim sometimes rises as high as over 1000 feet, sometimes sinks as low as 300, 200, or even 125 feet above the sea. Near the river mouth it is not surprising to find the watershed at a low level, but far inland these depressions are remarkable, especially as the minor watersheds rise to considerable heights. They are of great importance, as affording the easiest route from one river basin to another.

The most distant part of the Thames watershed is formed by a ridge of limestone, called the **Oolite ridge**, which will be traced later right across England from Dorset to Yorkshire. It attains its greatest height in the Cotteswold Hills, as part of the Thames watershed.

LESSON IX.

THE THAMES BASIN (*Continued*).

1. The source of the Thames is taken as the beginning of the stream shown near Sapperton Tunnel (Fig. 20). Following its course from here to the Nore, make a list of the *left-bank* and *right-bank* tributaries.

Which are the two longest tributaries above London? What towns are situated at their point of confluence with the Thames? Where is the longest stretch of the river without an important¹ left-bank tributary?

What right-bank tributaries come in within the same stretch? What differences are there in the geological formations on the two sides of this stretch? Which of the two would you infer to be the drier ground?

2. The following table gives statistics of eight counties, of which six are included almost completely in the Thames basin; the other two, Kent and Wiltshire, are partly included in that basin, but have large areas outside its limits. The county of London is not included in the table.

County.	Per-centage Culti-vated of Total Area.	Per-centage Arable of Culti-vated Area.	Per-centage Corn-land of Total Arable.	Per-centage Wood-land of Total Area.	Per-centage Heath-land of Total Area.	Popu-lation per 1000 Acres.	No. of Cattle per 1000 Acres.	No. of Sheep per 1000 Acres.
Berks. -	77.9	51	50	8.6	1.0	395	111	336
Bucks. -	83.4	35	52	7.2	0.6	375	173	380
Essex -	81.3	64	48	3.3	0.4	425	100	226
Herts. -	81.6	62	49	6.6	0.4	637	100	228
Oxon. -	86.2	50	49	5.1	0.3	288	146	432
Middlesex -	64.0	25	20	2.7	0.1	6812	119	100
Surrey -	57.7	39	41	12.8	1.5	1147	100	129
Kent -	76.1	41	39	10.2	0.8	946	97	934
Wilts. -	84.7	38	45	6.1	2.1	314	146	544
All England	76.0	44	46	5.3	7.3	930	154	466

Draw nine circles to represent these eight counties and England as a whole. Indicate on each with different coloured

¹ Tributaries not shown on Fig. 20 may be regarded as unimportant.

pencils, or by different shading as in Fig. 13, the proportion of cultivated land, woodland and heathland: the area remaining uncoloured is mainly covered by, or connected with, buildings, roads and railways.

3. Which two counties have the highest, and which two have the lowest percentage of their total area cultivated? A low percentage of cultivated land may be due to a high percentage of wood and heath, or to the presence of a large industrial population requiring many houses, roads and railways. By reference to columns 5, 6 and 7, see if you can trace the low cultivated area of Surrey and Middlesex respectively to either or both of these causes.

4. Make geological sketch-maps of the three counties—Essex, Kent and Surrey, taking the details from Figs. 16 and 22 so far as they go, and supplementing by reference to the geological map of England. Use only three colours or kinds of shading—one for chalk, one for sandy beds (Bagshot sands, Greensand, Wealden sands), and one for clays (London clay, Gault, Weald clay). By means of squared tracing-paper estimate the percentage area of these three kinds of subsoil. Tabulate your results and include in your table the proportions of woodland and heath and the number of sheep per 1000 acres.

Can you draw any inference as to which kind of soil is best for sheep, and which is least suitable for anything but woods and heath? What other county in the table on p. 49 has a large number of sheep? Does the geology of this county confirm your inference?

5. Measure and state in tabular form the distance (in a straight line) and direction (compass-bearing) of each of the following places from London and from Oxford:

Colchester (Co.),	Cambridge (C.),	Banbury (Ba.),
Swindon (Sw.),	Reading (R.),	Maidstone (M.).

6. Using Bartholomew's *Touring Atlas*, make a sketch-map of the Thames and its chief tributaries. By reference to the atlas place a red dot on the site of every town and village the name of which ends in *ford*, and a cross on the site of every one the name of which ends in *bridge*.

A *ford* is a place where it is possible to walk or wade across a river: such places were of great importance in times when bridges were few.

Soils and occupations.—In the last lesson the physical characters of the Thames basin were described. These characters are turned to their own account by the human beings who live within the basin, and it is now necessary to see how these inhabitants are distributed over the surface of the land—why they sometimes live in solitary farm-houses and cottages, sometimes in villages, sometimes in towns, large or small.

Starting in the oolite ridge, we find that the bare uplands support little else but short grass, suitable only for sheep (**pastoral land**). The land in the valleys, close to the stream, often has an alluvial soil, *i.e.* one formed of the material deposited by the river in flood; on such soil the grass grows richly, and is suitable for hay (**meadow-land**) or for cattle to graze (**pasture-land**). Between these two extremes the land, more sheltered than the sheep-downs, and drier than the hay-meadows and cattle-pastures, is suitable for the growth of corn and other crops, for which it must be ploughed (**arable land**). It is the raising of crops, including hay, that is meant by **agriculture** in the stricter sense; but more broadly the word is used to include cattle- and sheep-rearing, as these and other minor industries are all largely managed by the same farmers who till the soil. The reason for this is that much of the work of agriculture is concentrated at particular busy times of the year, so that the same man who is sheep-shearing in May is hay-making in June and corn-harvesting in August; while the work of ploughing and threshing, and the like, can be spread more or less over the rest of the year.

Thus, agriculture does not lend itself to the division of labour in the same degree as manufacturing industries which are independent of the seasons; also agriculture in the broad sense is the most self-contained of occupations. Centuries ago, when our population was mainly agricultural it was even more self-contained than now. Not only could an agricultural village produce its own bread and meat, but it also made its own clothing from the wool of its sheep. Still, it could never make everything it wanted, nor consume all it produced.

Market-towns.—Hence grew up market-towns, to which once a week came the farmers from a certain radius round, to sell their produce, and buy what they wanted. These little towns are scattered all over the country, and mostly show the same general characters. A market-town is situated generally in a river-valley, often at the confluence of two streams; if the river is wide, at a bridge or ford. There are mills on the stream to grind the farmers' corn; a brewery to make the barley into beer; inns where the marketers may eat and drink; shops where they may buy all they are likely to want, but among which those who are used to the shops of manufacturing towns will notice particularly tool-shops, saddleries, and corn- and seed-stores.

Practically all the towns in the Thames valley above London and its tributary valleys are primarily of this kind. But local industries may be added. Thus, near the great sheep-grazing uplands, **Witney** makes **blankets** and **Chipping Norton** tweed cloth from the wool. **Reading**, at the confluence of the Kennet, originally drawing its corn and flour from the adjacent area, makes it into **biscuits**; here also are great seed-growing grounds, and (by reason of its being an important railway-junction) engineering works. **Oxford**, at the confluence of the Cherwell, has its importance as a market-town overshadowed by the presence of an ancient **University** with many colleges.

The influence of London.—Farther down stream the towns become more and more influenced by the nearness of London. Men with business in London live even as far away as Oxford; at week-ends and holidays Londoners resort in great numbers to the riverside towns for boating, and the work of attending to the wants of the visitors becomes in some cases more important than the normal work of these towns.

Lastly, there is the great demand for food for London. Milk, at least, must be produced within 150 miles if it is to reach London fresh, and everywhere within that radius where a railway is at hand, farmers are being pressed to give more of their land for producing milk and other perishable goods for London, instead of the corn which can be brought equally well from America.

LESSON X.

THE WEALD.

1. Carefully copy the two maps of the Weald (Figs. 21 and 22). What geological formations on the former correspond in position to the areas on the latter marked respectively *North Downs*, *Greensand Hills*, *Northern Clay Vale*, *Southern Clay Vale*, *South Downs*, and *Romney Marsh*?

What formation forms the greater part of the main watershed (a) from Balcombe tunnel eastwards, (b) from Leith Hill westwards.

2. How many rivers cross the chalk area of the North Downs? In what direction do they flow across it? Of what river are most of them tributaries? Which of them rise in the Greensand Hills? Show, in a table, the course they take between these hills and the North Downs? Which of them rise in the hills of Wealden Sands? What course do they and their chief tributaries take in the northern clay-vale? Does any river flow along the northern clay-vale all the way to the sea?

3. How many rivers cross the chalk area of the South Downs? In what direction do they flow? In what directions do they and their chief tributaries flow in the southern clay-vale? Do any streams flow direct from that clay-vale to the sea? Can you make any general statement as to the directions of flow of the rivers of the Weald in the parts of their course that lie in vales and in hilly ground respectively?

4. Trace the form of the ground on the north and south sides of the North Downs: on which side is the escarpment? On which side of the South Downs is it? Compare Fig. 23. In which direction are the geological formations inclined (or in which direction do they *dip*) in the northern half of the Weald? In which, in the southern half? In what directions do the escarpments face in the two halves respectively?

What general statement can you make from this as to the relation of escarpments to the dip of the formation? Does this rule cover the case of the chalk escarpment on the north side of the London basin? What differences can you point

out between the geological structure of the Weald and that of the London basin?

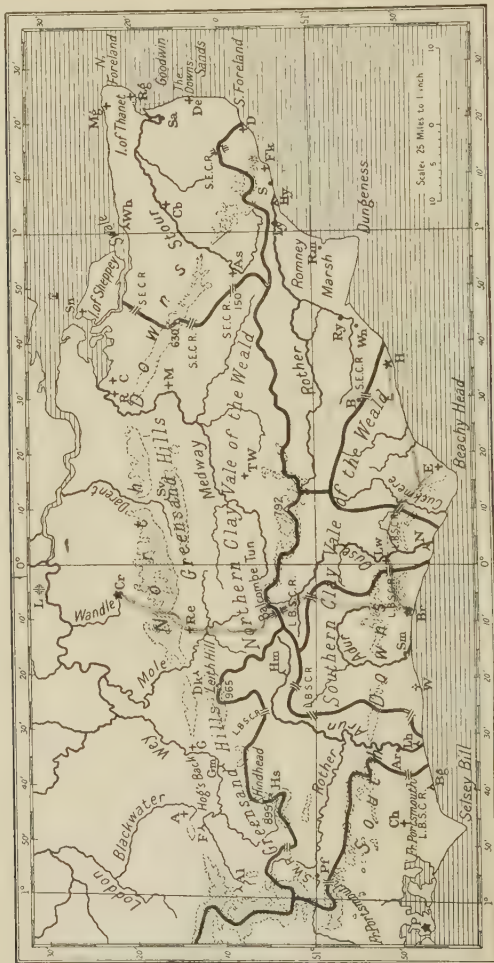


FIG. 21.—OROGRAPHICAL MAP OF THE WEALD.
The shaded areas are bounded by the 500-foot contour-line.

5. Make another copy of Fig. 21, marking only the coast, hills and rivers. Using Bartholomew's *Touring Atlas*, mark

by a black dot every place you can find with a name ending in *ing*; and by red and blue dots respectively all places with names ending in *den* and *hurst*. When this is done, write



FIG. 22.—GEOLOGICAL MAP OF THE WEALD.
(From *Geology for Beginners*, by Prof. W. W. Watts.)

down a statement as to the distribution of these place-names in the Weald.

The Weald.—From the south bank of the Thames estuary, the ground rises to a range of hills called the **North Downs**. Travelling in this direction, after a long steady ascent, the crest

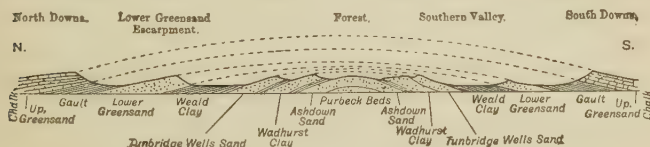


FIG. 23.—GENERAL SECTION ACROSS THE WEALD.
(Adapted from the *Proceedings of the Geologists' Association*, 1897.)
Vertical scale much greater than the horizontal.

of a ridge is suddenly reached from which a grand view extends over a vast area to the south. This area was once a dense forest: the Romans knew it as *Silva Anderida*, which the Saxons translated *Andredes Weald*—(the word Weald, like the German *wald*, meaning a forest), and it is now known as **the Weald**.

The crest of the North Downs is in places covered with beechwoods; where these are absent there is usually fine grass.

At many places great quarries have been cut in the hill-side, and these show that the whole of the hill is composed of chalk, with usually a very thin soil above it, suitable for grass to grow on, but not for trees, except the beech and a few others. Similar downs are found near the south coast—the **South Downs**—and can be traced as a sort of horse-shoe all round the Weald from Beachy Head back to Dover. The geological map shows these downs to be all composed of chalk, and the horse-shoe is part

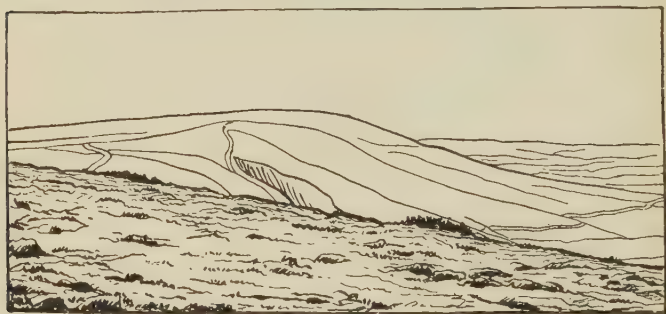


FIG. 24.—THE SOUTH DOWNS NEAR BRIGHTON, LOOKING WESTWARDS.
Drawn from a photograph by Mr. J. H. Pledge.

of an oval, broken into by the English Channel, but finding its completion in France.

At every part of the downs the side facing the Weald (the right-hand side in Fig. 24) has a very steep slope, while the opposite slope is much more gentle. This steep slope is called the **escarpment** of the chalk. At the foot of this escarpment, as in the case of most escarpments, lies a belt of clayey ground, which forms an inner horse-shoe. Enclosed by this lies the central high ground of the Weald, composed mainly of sandstone.

Geological structure.—It has been seen that the chalk of the North Downs dips beneath the London clay to the north. In just the same way the chalk of the South Downs dips under London clay to the south, near Chichester. The clays of the Weald dip in turn everywhere under the chalk and the central sandstones dip in each direction under the clays. The arrange-

ment of all these rocks is thus the reverse of a basin: it may be compared to a **dome** (Fig. 23).

The structure is not quite so simple as that just described. The clay-belt is divided into two by a sandstone band (the Lower Greensand), which is very insignificant in the southern half of the Weald, but forms a ridge in the northern half rising to nearly 700 feet near Sevenoaks, and nearly 1000 feet at Leith Hill and about Hindhead. Along the foot of the Chalk Downs there occurs a similar but much thinner layer, the Upper Greensand.

Drainage system.—Having thus a horse-shoe of low ground from sea to sea with high ground on either side, it might naturally be expected that the chief rivers would flow along the low ground to the sea; but this is not the case. Rivers do flow along the low ground, sometimes towards the sea, sometimes away from it, but only very small streams reach the sea by this route. All other rivers turn north or south through gorges across the downs. Of course the water does not flow uphill: the bottoms of the valleys across the chalk are lower than the watersheds in the plain. This is a remarkable illustration of the fact that valleys may intersect high ground while watersheds cross low ground.

The northern half of the Weald is part of the Thames basin, the southern half drains to the Channel. The main watershed corresponds in general to the central **axis** of the Weald, that is, to the line from which the strata dip away in opposite directions. Thus, the general flow of the streams is in the direction in which the rock-layers dip; while the belts of high and low ground follow the **outcrops** of the rock-layers, that is, the direction along which they appear at the surface of the earth. Valleys which thus run along the outcrop of a softer rock are termed **longitudinal** valleys, and the streams flowing along them, longitudinal streams; while streams and their valleys crossing the outcrops of both harder and softer rocks are termed **transverse**. Such a river as the Medway is longitudinal in some parts of its course and transverse in others.

Settlement.—The Chalk downs are very dry, but at the foot of the escarpment some of the water that has sunk down into

the chalk flows out in springs, and it is along this line of springs that most of the oldest villages are situated. Many of them have names ending in *ing*, as Charing, Kemsing, Malling, etc., which seem to be ancient family-names, *ing* corresponding to *son* in such modern surnames as *Johnson* and *Robinson*. In the heart of the Weald the place-names often end in *den* (a wood) or *hurst* (a wooded hill), showing that the land was a great woodland when men first settled there. Even to-day, when the woods have been largely cleared away, the counties in which the Weald lies are three out of the four which have the largest proportion of woodland in the kingdom—each having over 10 per cent. of its total area, or twice as much as the average of Great Britain.

Minerals.—From Roman times down to a century ago, the Weald was a great iron-making country. A very old piece of ironwork anywhere in the south of England—whether a gate, or a cannon or a fire-grate, is fairly sure to have been made in the Weald. The sandstone strata of the centre yielded much iron ore and the forest supplied wood-charcoal to smelt it. When the cheaper method of smelting by coal was invented, the Weald ironworks could not compete with those of Birmingham which had coal close at hand.

Nowadays the mineral production of the Weald is small. The two Greensands produce good building-stone and hard chert for road-mending, as well as much sand; and near **Redhill** there are valuable beds of **fuller's earth**, used for extracting grease from wool in cloth-making. From the clays are made bricks for London houses, and the chalk is extensively quarried. Gypsum is mined near Battle. Of late years, a more important mineral, coal, has been found in south-east Kent (outside the Weald proper), but at such great depths that it is too soon to say yet if it can be profitably mined. If it can, the iron industry may perhaps be revived. But at present the great industry of the Weald is agriculture, as will be seen in the next lesson.

LESSON XI.

THE WEALD AND THE KENTISH COAST.

1. Examine the following table; the four counties are those which include part of the Weald. Which of the county-areas (total acreage) differs most from the others? By what simple number could you multiply it to make it of the same order of magnitude as the others? By what round number could you then replace all the numbers in this line without serious inaccuracy? Why have the statistics for all England in the last column been divided by $33\frac{1}{3}$?

HOPS AND FRUIT.

		KENT.	SUSSEX.	SURREY.	HANTS.	All England. ÷ $33\frac{1}{3}$.
Total Acreage	- -	973,846	929,319	458,908	1,048,808	971,457
Acreage devoted to Hops, 1906	}	29,296	4,379	777	1,939	1,400
Yield of Hops in cwt. per acre (average of 10 years)	}	9.7	9.7	7.51	8.82	7.5 ¹
Acreage (1906) devoted to	Apples - -	12,395	2,591	1,356	1,475	5,058
	Pears - - -	935	140	148	68	258
	Cherries - -	6,215	103	41	74	360
	Plums - - -	3,080	173	326	313	438
	Strawberries -	7,628	282	302	2,154	708
	Raspberries -	2,380	53	104	137	195
	Currants and Gooseberries }	7,501	537	340	458	726
	Other Fruit -	8,963	545	965	277	677

2. Which of the counties in the table is the greatest hop-growing county? For what purpose are hops used?

3. Which is the greatest fruit-growing county in the table? Of what kinds of fruit does it grow more than ten times its

¹ England exclusive of Kent and Sussex.

share? Of which kind has it the greatest excess? Has it less than the average of any sort of fruit? Of what fruit does Surrey grow more than the average? [*Remember to double the Surrey statistics for comparison with all England.*] What other case of an excess can you find?

4. The number of sheep per 1000 acres in all England is 458, in Wales 755, Scotland 366. For the Weald counties it is—Kent 934, Sussex 429, Surrey 129, Hants 324; the highest and lowest numbers of other counties in the three divisions of Great Britain being Rutland 825, Middlesex 100, Brecon 1112, Pembroke 363, Roxburgh 1244, Ross and Cromarty 132. What position does each of the four counties of the Weald hold in respect of sheep-grazing?

5. Make a list of the towns that stand close to gaps in the North Downs. Do the same for the South Downs. Are there any important places close to the Downs and not near a gap?

6. Make a map, and on it trace the course of the following railways, and write a short description of each, stating

- (a) where they make use of a gap in the Downs,
- (b) where they cross any river,
- (c) where they follow a river-valley,
- (d) where they cross a main watershed, and whether they do so by tunnel or not:

S.E. and C.R. London *viâ* Chatham and Canterbury to Dover.

S.E. and C.R. London *viâ* Sevenoaks and Ashford to Dover.

L.B. and S.C.R. London *viâ* Croydon and (near) Reigate to Brighton.

L.B. and S.C.R. Portsmouth *viâ* Chichester, Worthing, Brighton, and Lewes to Hastings.

L. and S.W.R. London *viâ* Guildford, Godalming, and Petersfield to Portsmouth.

S.E. and C.R. Aldershot *viâ* Guildford and Dorking to Reigate and Ashford.

Cultivation of the Weald.—The subsoil of the Weald consists of alternate sandy and clayey formations. Where there are thick beds of clay, the land is only suitable for pasture or oak-woods; where thick masses of sand occur, for heaths and pine-

woods. But frequently clayey and sandy beds alternate, or the strata may be of mixed nature, or sand may be washed down from the hills to lighten the clay below. Wherever in any of these ways a well-mixed soil has been formed, it is very fertile. Kent, in particular, has so much land given up to **orchards** and **hop-fields** that it is known as "the garden of England." Hops are grown more extensively in Kent than in any other county, and a familiar feature in the landscape is the conical "oast-house" or kiln for drying the hops. The bare chalk downs, on the other hand, support sheep only, but "Southdown mutton" is famous.

Town-sites.—The inland towns of the Weald are mainly market-towns, situated at or near the points where valleys cut across the Downs. Ashford on the Stour has a great sheep and cattle market. Maidstone, Sevenoaks, Reigate, Dorking, and Guildford are related to gaps in the North Downs, as Arundel and Lewes are to those of the South Downs. As an invading army marching on London from the south coast would have to pass through some of these gaps, they either are or were formerly fortified. The castles at Lewes, Arundel, and Guildford show how important strategically those places once were, just as the name of Battle, near Hastings, brings to mind the Norman Conquest.

The north-east corner of Kent, though outside the Weald, is so closely connected with it that it must be considered here. The **Medway**, after crossing the chalk and entering the London basin, opens out into a wide estuary, at the head of which is the old cathedral- and castle-town of **Rochester** and the naval dockyard of **Chatham**, affording an important part of the defences of the Thames (Lesson V.). Where the Stour emerges from the chalk downs is the ancient capital of the kingdom of Kent, with the oldest cathedral church of England—**Canterbury**.

Changes in the coast-line.—The coast of Kent and the Wealden portion of Sussex is of great interest from the changes it has undergone. The Isle of Thanet is bordered by chalk cliffs, and here are the bracing seaside resorts of Londoners—Margate and Ramsgate. Much higher chalk cliffs occur where

the North Downs run down to the sea at Dover, and the South Downs at Beachy Head. The important port of **Dover** is situated where a valley breaks the continuity of the chalk cliffs, and at the nearest point to the continent of Europe. The ancient fortress of Dover Castle stands on the cliff above the town to protect it. The occasional great falls of chalk from these cliffs show that the sea, if not kept in check, will gradually destroy the land, separating England farther from Europe. But if the sea has been doing this in the past, England must have been nearer to Europe; indeed, it is easy to infer that it was once a part of the continent, and the sea has broken it away.

But elsewhere on this coast, where low-lying land comes down to the sea, the case is very different. The **Isle of Thanet** was once separated from the mainland by a navigable channel, now silted up by the material deposited by the Stour. The Roman fortress and landing-place of Rutupiae (Richborough) stands useless now 2 miles inland. The mediaeval port of **Sandwich** has been silted up, and the heaping-up of a shingle-bank by the sea has diverted the mouth of the Stour several miles to the north. South of Sandwich the sand exposed at low tide has been blown by the east wind up into **sand-hills** or **dunes**. Some miles off this part of the coast lie the dangerous shallows known as the **Goodwin Sands**, on which many vessels have been wrecked. The deeper water between these and the coast is known as the **Downs**.

On the other side of Dover low-lying ground is again found, and a remarkable accumulation of shingle at Dungeness—3 miles long, and from 1 to 4 miles wide, heaped up in ridges. A large part of this is known to have accumulated since Roman times, and its deposition here is due to the checking of the force of the tidal current that has brought it from the west, when it meets the current from the east. In Roman times there was behind this shingle bank a shallow bay, with a landing place at its head called *Portus Limanus*, now Lympne. This bay has gradually been filled up by the alluvium of the Rother, which originally flowed by Appledore, forming the low ground of **Romney Marsh**.

Coast-towns.—The towns on this coast are of two chief kinds :

(1) Ancient ports and naval stations, long engaged in fishery, in trade with the continent, and in helping in the defence of the coast. Chief of these are the **Cinque** (*i.e.* five) **ports**—Hastings, Romney, Hythe, Dover, and Sandwich, with the subsidiary ports of Rye and Deal. Of all these Dover has alone remained of its original importance.

(2) Towns of modern growth, either pleasure-resorts, as **Brighton**, Eastbourne, and Sandgate ; or **ferry-towns**, *i.e.* ports of departure for steamers to the continent, as **Newhaven** and **Folkestone**, and (on the north coast) **Sheerness**.

LESSON XII.

THE SOUTH COAST.

1. Examine Fig. 25. What is the scale? How many river mouths are shown? How many of these rivers rise within the area of the map? Which is the longest of these? Measure

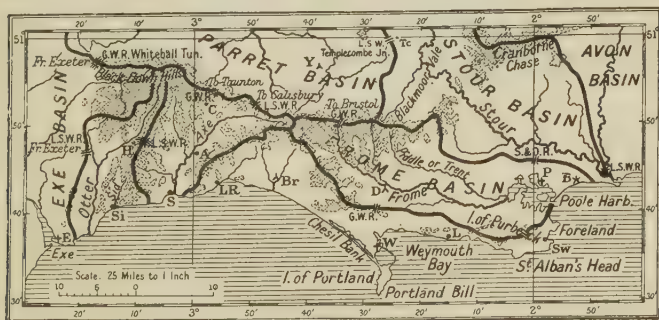


FIG. 25.—RIVER-BASINS OF THE SOUTH COAST.

The shaded areas are bounded by the 500-foot contour-line.

its length (approximately). Which rises farthest from the sea? Measure its length.

2. How many watersheds have to be crossed by the London and South-Western Railway between Templecombe Junction

(Tc. in the Vale of Blackmoor) and Exeter (in the Exe basin)? by the Somerset and Dorset Railway between the same junction and Bournemouth (B.)? By the Great Western between Yeovil (Y.) and Weymouth (W.)? Which must be the most level line of these three?

3. Which part of the coast has a long line of watershed close to it? What river-basin lies inland of that watershed? What sort of streams would you expect to find on the coast near that watershed? What part of the coast has the largest mass of high ground close to it? In what other parts of the coast does high ground come close to the sea? What sort of coast would you expect to find in such cases?

4. Examine Fig. 26. What is the scale? What area does the whole map represent? What is the breadth of Lulworth Cove (from east to west)? Where does the cliff attain its greatest height? Measure the gradient of the cliff-face at that point.

5. The coast-line of Fig. 26, in some parts, turns a convex outline to the sea, in other parts a concave outline. In most of the former places one of three bands of rock marked on the map come down to the coast. Can you think of any explanation of the connexion between a particular kind of rock and a particular form of coast?

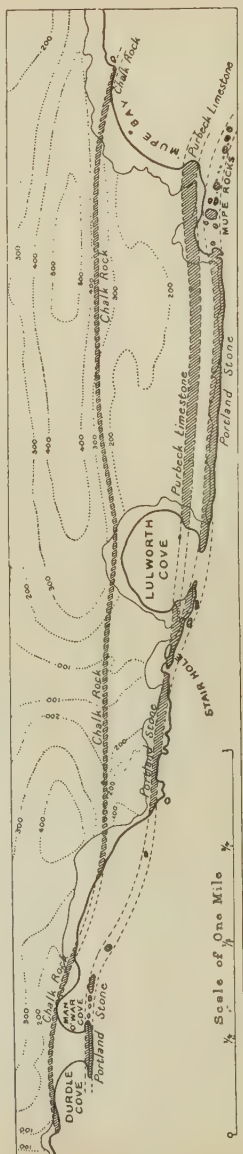


FIG. 26 — MAP OF PART OF THE DORSET COAST.

The unbroken line roughly parallel to the coast represents the edge of the cliff. The contour-lines are drawn at intervals of 100 feet. (After the Geological Survey and C. D. Sherborn).

What is the difference in form between Lulworth Cove and Man o' War Cove? Between the latter and Durdle Cove? What changes would make Lulworth Cove into something very like Man o' War Cove? On which side of Lulworth Cove are such changes most likely to occur?

6. Examine Figs. 28 and 29. How many times is the horizontal scale of Fig. 29 greater than the scale of Fig. 28? How many times is the vertical scale of Fig. 29 greater than the



Photo.

Frith and Co.

FIG. 27.—LULWORTH COVE FROM THE WEST.

Stair Hole is seen in front on the right.

horizontal scale. Find, on Fig. 28, the approximate line of section represented by Fig. 29. Compare Fig. 28 with Fig. 16, and Fig. 29 with Fig. 19.

7. How does the Hampshire basin differ from the London basin (*a*) in area? (*b*) In the completeness of its rim of chalk? (*c*) In the relative areas of Bagshot Sands and London Clay? On which side of each basin is the chalk rim narrow? What river in the Hampshire basin corresponds in position most nearly to the Kennet in the London basin? Which corresponds to the Upper Thames? Does this river drain from beyond the chalk escarpment? What other rivers in the Hampshire basin rise beyond the chalk rim? What in the

Hampshire basin answers to the position of the Thames estuary?

Are there any inlets similar to the *drowned valleys* of the Thames estuary? Of what geological formation is Portsdown

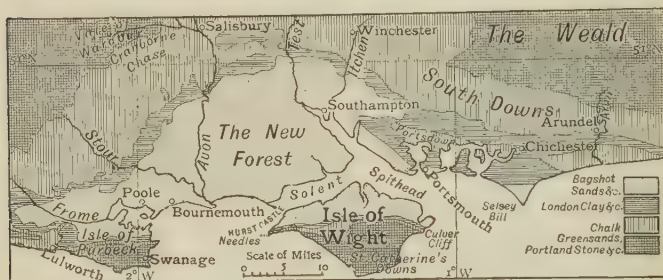


FIG. 28.—GEOLOGICAL MAP OF THE HAMPSHIRE BASIN.

composed? Is there anything similar to this in the London basin?

Two types of coast.—Examination of a railway map of England will show that to visit every important place along the south coast from Dover to Bournemouth, all the travelling can be done by railway without ever having to go very far

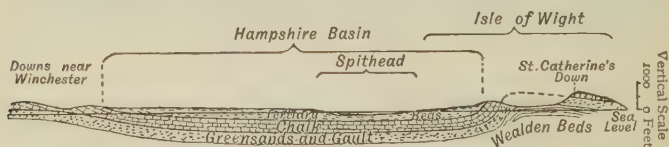


FIG. 29.—GEOLOGICAL SECTION ACROSS THE HAMPSHIRE BASIN.
Horizontal scale—10 miles to an inch. Vertical scale—1 mile to an inch.

inland, and that for considerable distances the train would be in sight of the sea. The only important exceptions are three—where the two low-lying peninsulas of Romney Marsh and Selsey cut off the railway from the sea, and where the South Downs come down to the sea in the high cliffs of Beachy Head, compelling the railway to go inland by Lewes. But from Bournemouth westward to Exmouth the case is very

different: there is no railway *along* the coast except for insignificant distances, so that, for instance, to get by rail from Bridport to Lyme Regis, the traveller must go 16 miles inland, to Yeovil, and change trains four times on the journey, travelling 50 miles to get to a place 8 miles away.

The reason for this difference is evident from an orographical map. From near Dover to Bournemouth the land that



Photo.

Photochrom Co.

FIG. 30.—THE NEEDLES, ISLE OF WIGHT.

The close similarity between the Chalk, with inclined layers of flint, of the mainland, and that of the detached pinnacles suggests their former continuity, and their separation by the destructive action of the sea.

comes down to the coast is mostly low, only broken by high ground here and there; while farther west masses of high ground come down to the coast, which consists of an almost continuous line of cliffs often several hundred feet high. The rivers that enter the sea on the former part of the coast are much longer, and rise farther inland than those on the latter. Near the point where the character of the coast changes stands the **Isle of Wight**, with its own southern coast largely formed of

cliffs, its northern coast flat and low, thus partaking of both characters.

Destruction of land.—The shape of the Isle of Wight is that of a lozenge or “diamond”—it projects out in sharp points east and west. The geological map shows that these are the ends of a long ridge of chalk that forms the backbone of the island. Beyond the western point a series of pinnacles of chalk, called the **Needles** (Fig. 30) stand up in the sea, which is slowly destroying them. Fifteen miles across the water the “**Isle**” of **Purbeck** (really a peninsula) has a similar projecting chalk foreland with similar chalk pinnacles in the sea—the largest is known as Old Harry: one called Old Harry’s Wife was destroyed by the sea some years ago.

Now, if the sea is destroying the points of the Isles of Wight and Purbeck that project towards one another, they must once have been closer together than they are now, and if we go far enough back in time we can imagine them once united.

How the sea set to work separating them can be seen farther west on the Dorset coast, where the process is going on on a smaller scale (Figs. 26 and 27). At **Lulworth** a belt of hard rocks fronts the sea: the sea has found a way through these and has swept away the softer rocks beyond much more quickly, forming a bottle-necked **cove**. If two coves were formed side by side they would soon join, cutting off an island of hard rock; this is seen at Man o’ War Cove, and the islands west of it. Similarly, the sea having broken through the hard chalk between Wight and Purbeck has swept out broad bays in the softer materials to the north. Before this was done the river Frome must have flowed along the Solent, and Spithead must have been its estuary.

Hampshire and London basins.—These facts being borne in mind while the geological map is examined, a striking resemblance will be seen between this region and the London basin (Figs. 28, 29 and 16, 19). Each is a geological basin, having a central area of clays and sands, running out to a point in the west, and bounded by chalk downs on the north and south. The Frome in one case, the Kennet and lower Thames in the other

flow eastward, keeping nearer to the southern border than to the northern. The Stour resembles the Upper Thames in rising beyond the chalk escarpment, and its Blackmoor Vale tributaries are, like the Thame and Isis, longitudinal streams in the vale at the foot of the escarpment. The Avon may be compared to the Lea.

The scenery in the two basins is much alike, especially where the soil is sandy. The pine-woods and heathery commons of Dorset and Hampshire are very like those of western Surrey: the **New Forest** and Windsor Forest alike owe their preservation as forests to the poverty of the soil for agriculture. Just as the Essex flats of the Thames estuary are indented by creeks, so with the Sussex and Hampshire coast; but here must be noticed an important difference. The Hampshire basin is interrupted by a fold which brings up the chalk in a ridge, **Portsdown**, parallel to the South Downs and just north of the series of harbours from Portsmouth eastwards. This adds greatly to the value of these harbours for naval purposes, as the ridge provides a site for protecting fortresses such as cannot be found on the Essex coast. The Hampshire basin is far smaller than the London basin, and very little of it is hidden by sea.

The destruction of the south coast by the sea has been described. Where has the material gone? Some of it forms the sand and shingle along the coast, and on the sea-floor. By the set of the tidal waves this shingle is continually being carried eastward. This is proved by the occurrence to the east of pebbles like those in the Devonshire cliffs; and also by the fact that wherever **groynes** (wooden barriers running across the beach down to low-water-mark) are set up on this coast the shingle always accumulates on their western side. The natural destination of the shingle is Dungeness, described in the last lesson. There is one other remarkable accumulation to be noticed—the **Chesil Bank**, a great bank of pebbles piled up by the sea along the coast from the Isle of Portland westward for ten miles.

LESSON XIII.

THE SOUTH COAST (Continued).

1. Examine Fig. 26. What part of this map was included in Fig. 22? What is the least distance from the coast at which the land reaches 500 feet on that part of the map? on the other part of the map (not including the Isle of Wight)? State in your own words the differences between these two types of coast-line. On which of them do you find large inlets of the



FIG. 31.—RIVERS OF THE SOLENT BASIN.
Contour-lines at 500 feet above sea-level.

sea? What coast studied in an earlier lesson had similar inlets? Was that coast similar to this one in other respects? What differences do you notice between the north and south coasts of the Isle of Wight?

2. Compare Fig. 31 with Fig. 28. What geological formation composes the Foreland (of the Isle of Purbeck), the Needles, and Culver Cliff? From what you learned in the last lesson can you suggest a reason why the shore-line recedes

sharply on the south side of these three projections, and also, but to a smaller extent, on the north? If there was a time when the Isle of Wight was not an island, with what part of the mainland was it probably most directly connected?

3. What geological formation constitutes the high ground around the Hampshire basin? What features does the same formation make on the coast? How would you explain the difference between these features (inland and coastal), and those shown by other formations adjoining it?

4. Plot a graphic representation of the following table on squared paper, as in Fig. 3, making a tenth of an inch represent an hour in the horizontal direction and a foot in the vertical direction.

HIGH AND LOW WATER AT SOUTHAMPTON ON TWO CONSECUTIVE DAYS.

H.W.	H.W.	L.W.	L.W.	H.W.	H.W.	L.W.	L.W.
1.20	3.20	7.30	9.30	1.40	3.40	7.50	9.50
2.0	4.0	8.12	10.12	2.23	4.23	8.36	10.36
a.m.	a.m.	a.m.	a.m.	p.m.	p.m.	p.m.	p.m.

Difference between high and low water, 17 feet.

5. Calculate, and represent by a percentage diagram (see Fig. 13 or 14) (a) the proportion of the chief items to the total import trade, (b) the same for the export trade, (c) Southampton's share of the total trade of the kingdom for each item in which it is in excess of the average.

THE CHIEF IMPORTS AND EXPORTS OF SOUTHAMPTON (1905).

IMPORTS.	Value.	Total of U.K.	EXPORTS.	Value.	Total of U.K.
	£1,000	£1,000		£1,000	£1,000
Fresh Beef - -	1,263	8,932	Cotton Manufac-		
Butter - -	1,872	21,587	tures - -	3,773	92,011
Potatoes - -	444	1,405	Apparel - -	1,253	6,021
Wool (Sheep) -	935	23,822	Leather - -	863	2,113
Wool (Goats') -	637	1,598	Woollen Manu-		
Feathers, Orna-			factures - -	740	29,917
mental - -	922	1,593			
Gutta-Percha -	124	361	Total Exports of		
Raw Coffee - -	450	2,578	British Manu-		
Raw Cocoa - -	318	1,409	facture - -	11,717	329,817
Bacon - -	754	12,775			
			Total Re-exports		
Total of all Im-			of Foreign and		
ports - -	15,342	565,020	Colonial Goods	3,408	77,780

Harbours and ports.—At many points along the south coast, principally at river-mouths, are found convenient places for small vessels to come safely to the shore and land the goods and men on board of them; and here from time immemorial small towns have existed, which are for trade by sea what market-towns are for trade inland. So long as there is sufficiently deep water close to the shore, and some protection from the dangers of a strong on-shore wind, and provided the land does not offer a barrier to an inland journey (either by being too precipitous or too marshy), there are all the requirements for a small port. But in course of time great differences show themselves between different ports. Just as some old market-towns no longer exist to supply the wants of surrounding farms and villages only, but manufacture goods for all parts of the country, so some ports trade with all parts of the world by sea and with a wide area inland by rail, while others remain small and carry on a local trade only.

Trade by sea is not the only business of ports: they may also serve as landing-places for fish and the home of fishing-fleets; they may be ship-building places; and they may be naval stations, concerned in the defence of the country against enemies in war. Examples of all these occur on the south coast, going no farther west in the present lesson than the mouth of the Exe.

A cliffed coast-line.—Along the westernmost part of this coast the ports are small, and situated at the mouths of rivers whose names they bear—Exmouth, Sidmouth, Axmouth (and Seaton), and Bridport. Their trade is purely local, except that the fish landed at them is sent mostly to London by rail. They are also resorts of holiday visitors in the summer. Between the river-mouths, most of the coast is cliffed too steeply for any town to exist; and where the cliffs become lower the Chesil Bank prevents any landing-place.

The **Isle of Portland** is famous for its building-stone, the excellence of which has been known since Sir Christopher Wren selected it for the construction of St. Paul's Cathedral. On the north side of the island artificial breakwaters enclose a

magnificent naval harbour, beyond which lies the port of **Weymouth**, which is not only a fishing-port and seaside resort, but also the starting-place of steamers to the Channel Islands and Brittany. Then follows a stretch of cliffy coast with no river-mouths and consequently no ports, except for the coves described in the last lesson, until we round the end of the Isle of Purbeck. Here, where Swanage Bay has been hollowed out by the sea acting on softer rocks more quickly than on those which are harder to north and south, is the port of **Swanage**, famous like Portland for its stone.

A low coast-line.—Where the sea has invaded the Hampshire basin it has flooded the valley of what was its central river, forming **Poole Harbour**, very wide but very shallow. This harbour is used chiefly for the export of white clays found among the Tertiary beds: these are used for making china, and over 50,000 tons are sent away annually to potteries in London and in North Staffordshire (Lesson XXII.).

Bournemouth is quite a modern town, purely a health- and pleasure-resort, on a sandy soil and among pine-woods by the sea-side, and owes its growth in large part to its good railway service.

Very different are the two other important towns a little farther east. **Southampton** owes its importance partly to its double tide (Lesson III.), which makes its docks approachable at all times of the day. Being on the south coast it naturally trades to the south, with the west and south of France, Spain, Africa, and North and South America and Australia. Vessels from these countries, carrying passengers or perishable goods, find it better to land them here for transport to London by rail than to take them the long way round by sea; so that Southampton might be included among London outports but for two considerations—that if the term outport is extended to Southampton it can hardly be refused to Liverpool or even Queenstown in Ireland; and that Southampton exports much of the produce of Manchester.

Portsmouth Harbour is the great naval station. As pointed out in the last lesson, it has a chalk ridge, Portsdown, to the

north of it, and this enables it to be protected by fortifications, without which a narrow-mouthed harbour would be a trap for war-vessels.

In both of these ports, and also at **Cowes**, in the Isle of Wight, there is a good deal of ship-building, but the vessels are generally towed to the Tyne or the Clyde to be fitted with engines.

LESSON XIV.

SALISBURY PLAIN.

1. Make a sketch-map of the course of the following railways (Fig. 31), referring, where necessary, to Bradshaw, and describing their course on the plan given below.

L.S.W.R. from Basingstoke (Ba.) through Andover (An.), Salisbury (Sa.), and Wilton (Wl.), to Yeovil (Y.).

L.S.W.R. from Basingstoke through Winchester (Wn.), Southampton (S.), Christchurch (Cc.), Bournemouth (B.), and Poole (Pl.), to Dorchester (D.).

G.W.R. from Yeovil through Dorchester to Weymouth (W.).

S. and D.R. from Glastonbury (in the Brue basin) to Bournemouth.

G.W. and L.S.W.R. from Bristol through Westbury (Wb.) to Wilton, Salisbury, and Southampton.

Example:—"The L. and S.W. railway from London to Exeter, soon after leaving Basingstoke crosses the watershed between the Thames and Solent basins by deep cutting in the chalk. It enters the upper valley of the Test, crosses to a tributary valley at Andover, and then skirts the margin of Salisbury Plain, reaching Salisbury by the valley of the Bourne, a tributary of the Avon. It crosses the Avon, and follows its tributary, the Nadder, along the Vale of Wardour, crosses the watershed into the Vale of Blackmoor (Stour basin) and another watershed into the Parret basin in which Yeovil lies."

2. Examine Fig. 32. What is the horizontal scale? Compare it with Fig. 23. What is the horizontal scale of that? What geological formation forms the high ground on each side of the Vale of Wardour? and of the Weald? What formations

come below the chalk in both cases? What formations are present in one and absent from the other? What differences do you see between the Vale of Wardour and the Weald (*a*) in width, (*b*) in the surface relief, (*c*) in the drainage?

3. Refer to the geological map of the British Isles. Make a geological sketch-map showing the areas of chalk between the south coast and the upper Thames Valley. The chalk of the Berkshire Downs is partly separated from that of Salisbury Plain by the Vale of Pewsey; Salisbury Plain is separated from the north-western rim of the Hampshire basin by the Vale of Wardour. Mark all these names on the sketch-map. How does the Vale of Pewsey resemble, and how does it differ from,

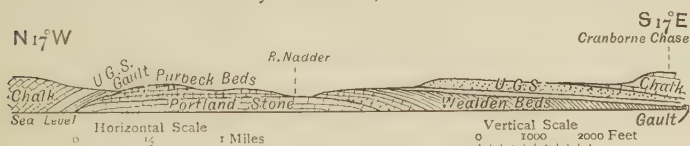


FIG. 32.—GEOLOGICAL SECTION ACROSS THE VALE OF WARDOUR.

the Vale of Wardour, geologically? Draw a diagram section across the Vale of Pewsey, on the model of Fig. 32.

4. On an outline county map of England and Wales place on each of the following counties a red dot for every thousand soldiers it holds; and mark by blue dots in a line along the coast the number of thousand naval men.

In what part of England and Wales is the Army and Navy concentrated? Why is this?

COUNTIES OF ENGLAND AND WALES IN WHICH MORE THAN 1 IN 300 OF THE POPULATION BELONG TO THE ARMY OR NAVY (1901).

	NUMBER OF THOUSAND MEN			NUMBER OF THOUSAND MEN	
	In Army.	In Navy.		In Army.	In Navy.
Berkshire -	3	0	London -	17	1
Cornwall -	1	3	Middlesex -	2	0
Devon -	4	13	Pembroke -	1	0
Dorset -	1	5	Surrey -	5	0
Essex -	6	1	Sussex -	2	1
Hants -	26	15	Wilts -	1	0
Kent -	16	12			

The main Chalk area.—The geological map shows, between the northern end of the Hampshire basin and the south-western part of the London basin, a wide area of chalk called **Salisbury Plain**. Eastwards, the chalk is split into a pair of narrow bands between which protrude the deeper rock-layers of the Weald. Westwards, the chalk ends in an escarpment which is a continuation of that seen crossing the Thames basin as the Chiltern Hills and Berkshire Downs. But on the western edge of Salisbury Plain this escarpment shows two conspicuous indentations, the Vales of Pewsey and of Wardour (Figs. 31, 32), which repeat the geological structure of the Weald on a much smaller scale. In the Vale of Pewsey only Greensand comes to the surface; but in the Vale of Wardour, besides the Greensand and Gault, and some very insignificant layers of the Wealden sandstones, the same building-stones as at Portland are found, and there are large quarries near Dinton.

The drainage of the whole district is southwards, and if the sea had not invaded the southern margin of the Hampshire basin, the **Avon**, **Test**, and **Itchin** would be simply tributaries of the **Solent** river. Salisbury Plain is not so much a plain as a **plateau**, for the most part standing about 500 feet above the sea; and the rivers, instead of flowing over its surface, are, as it were, **entrenched** in rather deep valleys. The chief river, the Salisbury Avon (so called to distinguish it from the many other Avons), rises in the Vale of Pewsey, turns into a valley cut across the chalk escarpment, and then flows almost straight south across the Plain and the Hampshire basin. Besides tributaries from the chalk area (of which the **Wylve** is the chief) it receives the **Nadder** from the Vale of Wardour, and just at its mouth the **Dorset Stour** which drains part of the Hampshire basin and the oolite area beyond. The Test and Itchin also flow from north to south, but do not drain anywhere beyond the chalk area. Unlike the Avon and Stour, they have a broad estuary. This is **Southampton Water**, and at its head stands the chief of our southern commercial ports.

A dry country.—The actual surface of the chalk plateau, like other areas of chalk, is very dry because the rain is

absorbed so readily by the thick mass of chalk beneath. Even in the valleys it sometimes happens that, in the drier months of the year, the streams are absorbed and flow underground, only appearing at the surface after heavy rain. Thus arises a **winter-bourne**, *i.e.* winter-stream, and this name is found as a frequent village-name in the chalk country. In the absence of small streams, the sheep and cattle on the plain obtain their water from **dew-ponds**—artificial diggings lined with clay and straw, which are kept full of water by condensation from the air. Most of the surface is only suitable for sheep-grazing, but in places turnips and wheat are grown, and much barley in the valleys, especially in the vales of Pewsey and Wardour. The villages all lie in the valleys, and at one time there was a considerable industry of cloth-making from the sheep's wool; but this is almost extinct, though carpets are still made at **Wilton**. The valleys form the chief routes of communication, and at the meeting of routes the chief towns lie. **Salisbury** is near the junction of the Nadder, Wylye and Bourne with the Avon—a more convenient trading-place than the hill-fortress of Old Salisbury (commonly called Old Sarum) which was its predecessor. **Winchester** lies at a narrowing of the Itchin valley. Both these were Roman fortresses, and are ancient cathedral towns. **Devizes**, at the western end of the Vale of Pewsey, is a rare case of a watershed market-town. The watershed here leaves the chalk ridge to cross the lower ground of greensand; and Devizes, just on the watershed, afforded a natural meeting-place for the inhabitants of the Vale of Pewsey with those of the basin of the Bristol Avon.

The railways follow the valleys, except the main South-Western line between Basingstoke and Salisbury, which crosses the plateau in many deep cuttings. It is interesting to notice that the chief of all the valleys (that of the Avon) has no railway along it except for short distances, because it does not afford a route between any important places.

The open, uncultivated character of the plain makes it useful as a field for military manoeuvres, and on it the Ordnance Survey measured the base-line, or starting-line, for the measure-

ment of the whole country. The same character has led to the preservation, through many centuries, of several monuments of antiquity, the most important of which is the great stone temple of **Stonehenge**.

LESSON XV.

THE CHALK RIDGE.

1. Examine Fig. 33. What is its scale? Find the country it represents on Fig. 20 and on the geological map of the



FIG. 33.—MAP OF A PART OF THE BERKSHIRE DOWNS.
Contour-lines are drawn at intervals of 200 feet.

British Isles. What geological formations are found (a) in the Vale of White Horse, (b) on White Horse Hill, Ilsley, and Lambourne Downs, (c) in the Kennet Valley?

2. Using squared paper, construct profile-sections from A to B and from Wantage to Newbury, with horizontal scale

3 times that of the map, and vertical scale 1 inch = 1000 feet.¹ How many times is the vertical scale exaggerated as compared with the horizontal?

3. What difference do you notice in both sections between the slope northwards and southwards from the highest point? On the map, what difference do you notice between the contour-lines of 400 and 600 feet north and south of the highest ridge?

When a mass of high ground, composed of gently-inclined rock-layers, has slopes of these two very marked kinds in opposite directions, the steeper one is called an **escarpment**, the gentler a **dip-slope**.

Which is the escarpment in this case?

Measure the distances between successive points whose altitude is known along the Wantage-Newbury line and calculate the true average gradient from point to point.

4. What difference do you notice between the courses of the two ancient roads shown on the map and those of the railways nearly parallel with them?

5. Represent by a graph the decrease in the importance of the straw-plait and straw-hat industries from east to west along the Chiltern ridge.

THE STRAW-PLAIT AND STRAW-HAT INDUSTRY, 1901.

	Total Occupied Population ÷ 1000.	Number of Thousands engaged in Straw Industries.
Bedfordshire - - - - -	77	12
Hertfordshire - - - - -	109	2
Buckinghamshire - - - - -	82	0.2
Oxfordshire - - - - -	79	0.0
England and Wales - - - - -		15.

6. Calculate the average gradient along the following lines of railway:

Great Western, from Didcot to point A.

Great Western along Kennet Valley, in three sections divided by points where heights are marked.

¹ If the squared paper is ruled in millimetres, 1 cm. = 1000 feet.

Lambourn branch, from Newbury to 400 contour.

Didcot and Newbury line, in five sections.

Which of these lines has the easiest gradients, and which the hardest? Which of them follows most closely along the same geological formation, and which one goes most directly across several formations?

The Chiltern Hills.—The Chalk escarpment, the crest of which forms the bold east-and-west line of the Berkshire Downs, is continued across the Thames by the line of the Chiltern Hills, with a bend to the north-east instead of to the east. Between the two hill-ranges the valley of the Thames is narrowed almost to a gorge, between the confluence of the Thame and that of the Kennet. From here to Hitchin, the hills show the same features as the chalk downs elsewhere; yet they are distinguished, especially from the Berkshire Downs, by certain features of their own. In the first place, although no river-valley is found cutting across the line until we reach the Lea at Luton, there are several deep notches or gaps in the escarpment, continued to the south-west by valleys, at first dry, but farther south occupied by tributaries of the Thames. It is convenient to call these dry notches **wind-gaps** to distinguish them from the **water-gaps** through which transverse rivers flow. As the Chilterns form a barrier of high ground between London and the districts beyond, these valleys and gaps afford easy routes of communication, and the five deepest of them at Prince's Risborough, Wendover, Tring, Luton and Hitchin are occupied by main lines of railway.

The Berkshire Downs, on the other hand, are crossed only by two single-line railways with steep gradients, leading to no place of first-rate importance, while a third penetrates to a terminus at Lambourn. Hence, the Chiltern region has within easy reach a great population and is busier and more populated than the downs across the Thames. There are also two special local industries, which though beginning as very small-scale crafts have led to the growth of factory-towns. The first is chair-making, which owes its existence to the beech-woods on the chalk. Some of the rougher work is still done in the

woods themselves, or in little village workshops, but in **High Wycombe** there are large factories for furniture of all sorts, not merely of beechwood.

Straw-plaiting.—The other industry has its centre in **Luton**, the district around which furnished straw of a kind specially suited for plaiting ; but now the local supply of straw is far too small for the output of straw hats from the Luton factories. We see here a good example of what has been termed **industrial inertia**. Physical inertia is the tendency of a body to remain at rest or continue moving in one direction, and industrial inertia is the tendency of an industry to continue in the same place, when the reasons that led to its establishment there no longer apply. Straw-plait from China and Japan is landed in the London docks, sent 30 miles by rail to Luton to be made into straw hats, most of which are sent back to London to be sold. It would seem much simpler to do it all near the London docks, and if the industry had originally depended on imported straw that is very likely what would have been done.

There are other cases where industrial inertia has not been strong enough to keep an industry going in its old home when conditions have changed ; the iron industry of the Weald is an example. At the same time, it must be remembered that modern facilities for transport, especially railways, are making industries less and less dependent on local conditions. Not far from Luton itself, at **Letchworth**, can be seen an experiment in the establishing of a new industrial town, Garden City, with no local attractions except plenty of space, laid out with forethought, and good railway communication.

Beyond Hitchin the chalk escarpment becomes less and less high and distinct, and although it can be traced to the Wash and also in a northerly direction through Lincolnshire, it does not become a conspicuous feature again until the East Riding of Yorkshire, where it curves round to the east, ending in the chalk cliffs of **Flamborough Head**. The chalk hills of Lincolnshire and Yorkshire are not called downs but **wolds**.

LESSON XVI.

THE CLAY VALE AND THE FENS.

1. Examine Fig. 34. What are the three rivers whose basins lie entirely within the map? What is the name of their



FIG. 34.—BASINS OF THE GREAT OUSE, NENE AND WELLAND.
The shaded areas are bounded by the 500-foot contour-line.

joint estuary? What name is given to the district through which they flow before reaching that estuary?

2. In what parts of the map does the land rise to over 500 feet above sea-level? What geological names are given to those parts? In what general direction do all the ridges and main rivers in this map run?

3. Measure the joint area of the three river-basins.

4. Make a tracing of the watersheds on Fig. 34, and on it join up the courses of the following railways:

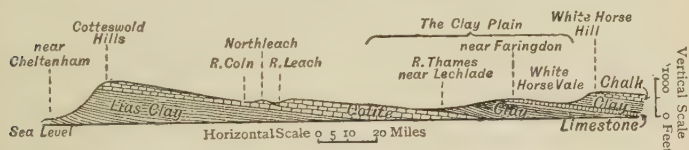


FIG. 35.—SECTION ACROSS THE OXFORD CLAY VALE.
The height of the Cotteswold Hills has been made too great.

(1) *Main lines from London—*

L.N.W.R. through Wolverton (Wv.) and Northampton (N.) to Rugby (Rb.);

M.R. through Bedford (B.), Wellingborough (W.), Kettering (K.) and Market Harborough (M.H.) to Leicester (L.);

G.N.R. through Hitchin (Hi.), Huntingdon (H.) and Peterborough (P.) to Grantham (G.);

G.E.R. through Cambridge (C.) and Ely (E.) to King's Lynn (K.L.).

State in each case how many watersheds have to be crossed. Which of these lines should you expect to have the easiest gradients and which the hardest?

(2) *Cross-country lines—*

G.E.R. Cambridge to Ipswich (I.);

L.N.W.R. Northampton through Wellingborough to Peterborough;

L.N.W.R. Rugby through Market Harborough to Stamford;

M.R. Leicester, through Melton Mowbray (M.M.), Spalding (Sp.) and King's Lynn to Norwich.

How many watersheds does each cross? Which should have the easiest gradients?

5. Examine Fig. 35. How many miles does an inch represent on the horizontal scale? How many feet does it represent on the vertical scale? What is the exaggeration of the vertical scale? Find on the geological map of the British Isles the situation of the line of section. How many ridges and valleys are shown in the section? Write a list of them, putting against each valley the name of the river flowing in it, and the geological formation in which it lies; and against each ridge, whether it is a main or minor watershed and the formation it is composed of.

6. In what parts of Great Britain are situated the highly-cultivated counties included in the table given below? Omitting Anglesey, divide them into four groups, according as the arable land forms (*a*) less than 40, (*b*) from 40 to 50; (*c*) between 50 and 60, (*d*) over 60 per cent. of the cultivated land.

What is the geographical position of each of these groups? Indicate them by four different colours or kinds of shading on an outline county map.

COUNTIES OF GREAT BRITAIN HAVING 85% OR MORE OF THEIR TOTAL AREA CULTIVATED.

	Per-centage Cultivated.	Per-centage of Arable in Cultivated.	Per-centage of Corn-land in Arable.	Popula-tion per 1000 acres.	Cattle per 1000 acres.	Sheep per 1000 acres.	Percentage in Total Area of		
							Wood-land.	Heath, etc.	Ba-lance.
Anglesey -	86.1	45	30	286	317	534	1.4	5.6	6.9
Bedford -	85.0	57	47	567	123	290	4.4	0.5	10.1
Cambridge -	89.3	75	53	316	109	303	1.2	0.2	9.3
Huntingdon	89.4	58	52	231	130	350	2.2	0.1	8.3
Leicester -	89.3	20	50	821	270	572	2.7	0.2	7.8
Lincoln -	89.9	66	49	295	151	587	2.6	0.1	7.4
Northants -	88.2	34	53	470	212	594	4.5	0.0	7.3
Oxon -	86.2	50	49	388	146	432	5.1	0.3	8.4
Rutland -	90.0	38	54	203	202	825	3.9	0.0	6.1
Warwick -	86.0	30	48	1620	200	435	3.5	0.2	10.3
Yorks (E. R.)	89.6	67	51	595	123	557	2.4	0.3	7.7
All England for com- parison	76.0	44	46	876 E. & W.	156	458	5.3	7.3	11.4

Omitting Anglesey, what is the highest and what the lowest percentage of corn-land in the arable? Express the difference between highest and lowest as a percentage of the lowest. What general statement could you make about the figures under this heading?

Which two counties have the greatest population in proportion to their size? Which counties have coalfields within their limits?

Which counties have more cattle per given area than the average of England? What other fact have you already learned about the same counties? Are the facts connected?

Which counties have more than the average proportion for England of sheep? This differs from the last group of counties by the omission of one and the addition of two others. You have already learned that sheep thrive on the downs of chalk and oolite. Look at the geological map and see whether the sheep-counties have much chalk or oolite within their limits.

The land beyond the chalk.—The existence of an escarpment is due to the fact that below the hard strata that form its crest softer beds appear in the vale at its foot. These softer beds are usually of clay. From the foot of the chalk escarpment which has been traced from Salisbury Plain to Yorkshire there stretches to the west and north-west a plain or vale made of clay, divided frequently into two or more parallel vales by low ridges of sandy or limestone strata forming divisions in the clay (Fig. 35). This broad vale may be called the **Oxford Clay Vale**. On the geological map to the scale of 25 miles to an inch, it is not practicable to distinguish these alternate strata (as is done on larger scale maps), and they are all (except the Greensands and Gault Clay close to the Chalk) coloured yellow. While clay predominates in the eastern half of this great yellow band, the western part consists mainly of limestone which rises up into a well-marked belt of high ground—the **Oolite Ridge**.

The **Clay-vale** begins with the Vale of Blackmoor, drained by longitudinal tributaries of the Dorset Stour (Fig. 31). After a narrow portion, not separately named, it is continued as the broad longitudinal part of the valley of the Bristol Avon. It forms one of the lowest parts of the Thames watershed, where

the Great Western Railway crosses it near Swindon ; and then continues as the **Vale of White Horse** at the foot of the Berkshire Downs, in the chalk escarpment of which is cut the ancient White Horse that gives the vale its name. Crossing the Thames it forms the **Vale of Aylesbury**, and after another low pass the lower valley of the Great Ouse.

Cornland changed to pasture.—Throughout its extent this belt is good pasture-land, and produces large quantities of milk, mostly sent by rail to London. In places, beds of sandstone and limestone among the clay produce a mixed soil, and the same result is produced in the Ouse valley by the presence of boulder-clay (see next Lesson). In these regions the land is largely arable, and the clay-soils were also ploughed in former times, as is evident from the grass-meadows being frequently marked out in broad wave-like ridges and furrows, produced by old methods of ploughing. Although this feature is not confined to the clay vale (it may be seen also in the Oolite country and farther west, and sometimes on the London clay) it is perhaps commoner here than anywhere else. It brings to mind the time when England grew far more corn than now, because it had to grow all its corn itself, even though for a much smaller population. The only large towns on this part of the vale are Oxford (p. 52) and **Swindon**, an important junction of the Great Western Railway near the Thames watershed, chosen as the site of its locomotive and carriage works.

The Fens.—The clay-vale gets wider as it is followed to the north-east, and at the same time lower, until it sinks almost to sea-level, and enters the district known as the Fens. Here the clay itself sinks below sea-level, and is covered over by thick alluvial deposits, except where it stands up in a few low hills like islands among the flats.

The Fens are in a sense the **delta** of the combined rivers Ouse, Nen, Welland and Witham, filling up what was once the upper part of the great estuary of the Wash, but unlike a true delta, most of the silt is brought from the destruction of the Yorkshire cliffs by the tidal currents, comparatively little being deposited by the rivers. Within historic times the whole district was a

sheet of shallow water, at least at times of high tide or river-flood, and the low hills were really islands, as is shown by their names which end in "ea" or "y." The chief of these is **Ely** (the isle of eels), with its fine cathedral, which is a landmark for many miles. Others are, Ramsey and Whittlesea. Gradually the Fens were embanked and drained, and now form some of the most fertile land in the country. Cambridgeshire is the county with the highest percentage of arable land—over two-thirds of its total area. Mustard is a special crop of the Fens.

As the Fens were embanked and drained, small ports grew up at the mouths of the rivers—Lynn, Wisbech, Spalding and **Boston**; but with the continued silting-up of the Wash these have lost much of their trade. On the edge of the Fens we find larger towns, **Peterborough**, **Huntingdon** and **St. Ives**, primarily market-towns for the exchange of goods brought by land and water, but also manufacturing agricultural implements, and in the case of Peterborough making immense quantities of bricks (a modern industry) for London builders. In a similar situation stands the university town of **Cambridge**. Higher up the Great Ouse than Huntingdon we find **Bedford**, formerly a quiet market and county-town, but now, thanks to its position on the main line of the Midland Railway, becoming a manufacturing town.

LESSON XVII.

EAST ANGLIA.

1. Examine Fig. 36. What contour-lines are marked on it? How do these differ from those marked on previous river-basin maps? Why is it necessary to make this difference? What does it indicate as to the general physical character of the region?

What is the easternmost place where the ground rises to 400 feet above the sea?

2. What is the largest town in this area (not including London)? What are the two next in importance? What are their populations?

London through Cambridge (C.) and Ely (E.) to Kings Lynn (K.L.).

Peterborough (P.) through March (M.), Ely, Bury St. Edmunds (B.E.) and Ipswich to Harwich (H.).

4. Represent the statistics of the table given below by a series of diagrams on the model of Fig. 37, marking in each case upon the curved line the points where it reaches the figures of Norfolk, Suffolk and Essex respectively.

In each case the vertical lines representing maximum, average and minimum must be at equal distances apart. The curve may sometimes be convex upwards, sometimes concave. What does its curvature indicate? In what circumstances might it be a straight line?

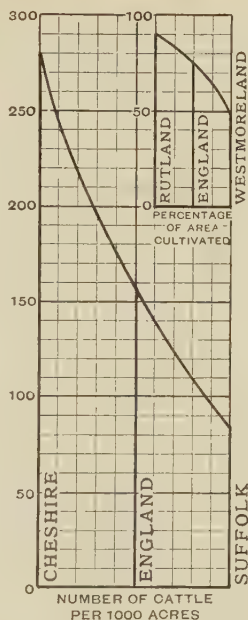


FIG. 37.—EXAMPLES OF MAXIMUM-MINIMUM CURVES.

In each case the left-hand vertical line represents the county with the highest proportion; the right-hand line, that with the lowest proportion; and the middle line the mean of all England.

AGRICULTURE IN EAST ANGLIA AND ESSEX (1907).

	Per-centage Cultivated.	Per-centage of Arable in Cultivated.	Per-centage of Corn-land in Arable.	Cattle per 1000 acres.	Sheep per 1000 acres.	Percentage in total area of			Rainfall.
						Wood-land	Heath.	Ba-lance.	
Norfolk - -	81.7	73	49	108	364	4.5	3.6	10.2	26
Suffolk - -	79.9	74	49	84	354	4.0	3.0	13.1	23
Essex - -	81.3	64	48	100	226	3.3	0.4	15.0	24
All England (exclusive of Wales) average - -	76.0	44	46	156	458	5.3	7.3	11.4	—
Highest County	90.0	75	—	281	825	13.2	42.0	—	60
Lowest County	49.6	15	—	84	100	1.2	0.1	—	23

5. Calculate the average densities of population from the table given below, and represent them graphically by a series of dots in an inch square, showing the number of persons in 100 acres in each case.

AREA AND POPULATION (1921).

	Towns.		Rural Districts.		TOTAL.	
	Area, 1000 acres.	Popula- tion, 1000.	Area, 1000 acres.	Popula- tion, 1000.	Area, 1000 acres.	Popula- tion, 1000.
Norfolk - - -	53	246	1,262	258	1,315	504
Suffolk - - -	56	212	892	188	948	400
Essex - - -	117	1,194	862	274	979	1,468
All England and Wales -	—	—	—	—	37,340	37,885

6. Find, from the table given below, the proportion by weight landed at Yarmouth and Lowestoft of all the fish caught in nets off the east coast of England. Find the proportion landed at the same ports of the fish caught by trawl and line. What is the average value of a cwt. of the former class of fish landed at Yarmouth and Lowestoft? landed elsewhere? What is the average value of a cwt. of the latter class of fish at Yarmouth? At Lowestoft? Elsewhere? What is the value of shellfish landed at Yarmouth? At Lowestoft?

EAST COAST FISHERIES.

	Weight of Fish.		Value of Fish.		
	Caught by net.	Caught by trawl and line.	Caught by net.	Caught by trawl and line.	Total, including Shellfish.
	1000 cwt.	1000 cwt.	£1000	£1000	£1000
Yarmouth - - -	1,280	11	503	11	514
Lowestoft - - -	957	277	366	302	668
Rest of East Coast from Berwick to Dover - }	805	5,729	276	4,400	4,877
Total, East Coast	3,042	6,017	1,145	4,713	6,059

East Anglia, consisting of the counties of Norfolk and Suffolk, is a well-defined area, being bounded by the sea on the east and north, and the low-lying Fen district on the west. From Essex on the south it is separated only by the Stour and its estuary, and it will be convenient to include Essex in this lesson.

The whole of this district is undulating ground, rarely rising over 200 feet above the sea, drained by a number of small rivers with watersheds mostly low and ill-defined. The geological map shows three formations as occupying roughly equal areas—Chalk, London Clay and **Crag**—the last being a loose shelly gravel. The map is misleading, however, for over most of the area except in its western part these formations, though present at a little depth, are covered over by a variable thickness—up to as much as 200 feet—of what are called by geologists **Glacial Deposits**. There is evidence that at one time nearly all of Great Britain north of the Thames was covered by a thick sheet of ice, like that now existing in Greenland. Where this melted, as in East Anglia, it deposited a great mass of mixed materials, principally in the form of **Boulder Clay**—a clay formed of powdered rocks of all kinds, with broken fragments of all sizes scattered through it. Elsewhere streams formed from the melting ice deposited great sheets of coarse gravel.

Cultivation.—The area of fluvio-glacial gravels is largely occupied by heaths and woods, but the soil overlying boulder-clay is usually very fertile, owing to the mixture of materials. On the heavier (more clayey) soils wheat is grown; on the lighter (more sandy), barley. The northern part of Norfolk is especially famous for barley. Norfolk and Suffolk have 60 per cent. of their whole area arable, as against 33 per cent. for England as a whole. They are only beaten by Cambridgeshire (67 per cent.) and equalled by Lincolnshire and the East Riding of Yorkshire. Essex has 52 per cent.

While East Anglia proper has always been well-cultivated, Essex was until the last few centuries a thickly-wooded county. Remnants of its old forests are still preserved as pleasure-woods for Londoners in **Epping** and **Hainault Forests**. Owing to the abundance of timber and absence of building stone, most of the old churches of Essex were of wood, and some are still preserved. In East Anglian churches a different peculiarity may be noticed: here the only building-stone is flint, and the church towers are round, because flint is unsuitable for square corners. In those parts where the chalk is not

covered by boulder-clay, as at Brandon, the flints are dug to be used in flint-lock guns for export; they are also sent away to be used for flint-glass and porcelain-making.

Changes in coast-line.—The type of shore-line with drowned valleys that can be seen along the Essex coast does not continue far into Suffolk. A remarkable river-mouth is that of the Alde, or Orford river, which has been turned nearly 10 miles south by the growth of a shingle beach: the original mouth must have been at Aldborough; in the sixteenth century it was at Orford. A similar shingle beach is seen at Blakeney on the north coast, and Lowestoft Ness is a great accumulation of shingle. Other parts of the coast have been destroyed greatly by the sea: Dunwich was once a great town, now most of it is gone, and the church stands dangerously near the edge of the cliff. Elsewhere the east wind blowing over the sands exposed at low tide has raised great sand-dunes, especially on the north and north-east coasts. Eccles church (between Yarmouth and Cromer) was buried in the sands, but they have now been carried past it.

The rivers of East Anglia need not be considered in detail. On the course of, or alongside some of, the Norfolk rivers are shallow lakes called **broads**.

Towns.—The towns are mostly small market-towns, but two at least are very large and busy. **Norwich**, situated at what was the head of navigation of the Yare, at its confluence with the Wensum, an old town with a Norman castle and cathedral, manufactures principally boots and shoes and mustard (grown in the Fens). **Ipswich**, at the head of the Orwell estuary, manufactures agricultural and other machines. The catching and preserving of herrings support the populations of **Yarmouth** and **Lowestoft**. The fish are caught in the autumn in long nets, fastened end to end, sometimes to a length of over a mile, and a million herrings may be landed in a day. **Harwich**, in Essex on the Stour estuary, trades with the continent, and especially carries passengers to and from Holland and Germany, being within an hour and a half of London by rail. Felixstowe, Cromer and Hunstanton are pleasure-resorts on the coast.

LESSON XVIII.

THE OOLITE RIDGE.



Emery Walker Ltd. sc.

FIG. 38.—RIVER-BASINS AND WATER-PARTINGS OF ENGLAND AND WALES.

1. Examine Fig. 38. Why are three of the watershed-lines distinguished from the rest by being drawn as continuous lines? Note the point at which these three meet: find this

point on Fig. 31. Near what town does it lie? How far from it and in what direction? If you were standing at this point, what could you say about its relation to the river system of England?

2. Measure the distance, in a straight line, from this point to the nearest points on the east, south, and west coasts respectively. What three rivers follow most nearly in their courses the directions of these three straight lines? Measure, as nearly as you can on Fig. 38, the lengths of these three rivers.

3. What are the general directions in which the three main watershed-lines run from this point? Make a sketch-map of England and Wales, marking these lines. Then by reference to the geological map write on each portion of the line running northwards, the main geological formation which it follows, thus—Chalk ridge, Oolite ridge, Marlstone ridge, New Red Sandstone, Carboniferous rocks.¹ Do the same for the southern lines where the geology is not too intricate to be expressed in broad terms.

4. Measure the areas of land draining to the eastern, southern and western seas respectively.

5. What river-basins make the biggest indentations into the straightness of the northern and western watershed-lines?

6. On another sketch-map trace the series of watershed-lines that keep most nearly along the outcrop of the Oolites. Make a list of the river-basins which they separate, and a list of the cases where this line forsakes the Oolites to run along the Lias.

7. On an outline county-map of England and Wales, by reference to the table on p. 95, shade with pencil the counties which produce iron ore, those raising millions of tons very dark, those raising hundreds of thousands a medium shade, and the remainder lightly. Indicate the number of furnaces in each county by dots (one dot to every 10 or fraction of 10). Indicate the imports of iron ore by a black circle in the sea adjoining each port roughly proportionate to the amount imported (four different sizes of circles will be sufficient).

¹ See p. xiv, for the relation of these terms to those used on the geological map.

IRON MINING AND SMELTING, 1906.

County.	Iron Ore raised (1000 Tons).	No. of Furnaces in Blast.	County.	Iron Ore raised (1000 Tons).	No. of Furnaces in Blast.
Cumberland -	1,276	23	Oxford and Rutland	179	0
Derby - - -	0	36	Shropshire - -	19	3
Durham - - -	13	28	Stafford - - -	1,004	32
Gloucester - -	9	0	Warwick - - -	1	0
Lancaster - - -	405	16	Wilts - - -	83	1
Leicester - - -	710	18	Worcester - - -	5	3
Lincoln - - -	2,358		York (Cleveland) -	6,113	59
Monmouth - - -	11	10	York (West Riding)	50	16
Northampton -	2,251	13	Glamorgan - - -	11	12
Nottinghamshire-	0	5			

Imports of Iron Ore, 1906 (1000 tons).	Imports of Iron Ore, 1906 (1000 tons).
Middlesbrough - - - 1828	Maryport - - - 538
Cardiff - - - 927	Stockton-on-Tees - 293
Newport - - - 591	Barrow-in-Furness - 280
N. and S. Shields (Tyne) 554	

8. On a second outline-map sketch in from the geological map and shade the areas occupied by Oolites, Lias and Coal Measures. Compare this map with the other, and see how far the shaded areas correspond.

9. Make percentage diagrams to show (a) the proportion to the whole quantity of the ore raised in the 5 chief districts, (b) the proportion of home-raised to imported ore.

10. Calculate the percentage of occupied persons engaged in the boot and shoe trade for the counties in the table on p. 96 in which the percentage is high, and for the neighbouring counties taken as a whole. Represent the facts by percentage diagrams.

NUMBERS OF PEOPLE OCCUPIED IN BOOT AND SHOE
MAKING, 1901.

County.	All Paid Occupations.	Boot and Shoe Making.
	1000	1000
Bedfordshire - - - -	77	1
Buckinghamshire - - -	82	2
Derbyshire - - - -	258	3
Leicestershire - - - -	209	35
Lincolnshire - - - -	207	1
Northamptonshire - - -	149	42
Nottinghamshire - - -	225	2
Oxfordshire - - - -	79	1
Staffordshire - - - -	528	8
Warwickshire - - - -	438	3

Oolite and Lias.—The Oxford-clay vale is defined sharply on its eastern and south-eastern side by the Chalk escarpment, but in the opposite direction it passes gradually and indefinitely into the high belt of the Oolite ridge. This ridge is composed very largely of a yellowish limestone full of little rounded grains, about the size of a small pin's head, like tiny eggs: from this character it receives the name of **Oolite** (egg-stone). On its western side the Oolite presents a steep escarpment facing another broad clay-vale,—the **Lias belt**—but in this vale there is a minor ridge of hard rock called **Marlstone**, which in part of the Midlands near Leicester attains a height of over 700 feet, and then it, not the Oolite ridge, forms the main watershed. Thus the Evenlode and Cherwell, Nen, Welland and Witham all rise beyond the Oolite escarpment and cut across it. On the other hand the valleys of the Bristol Avon and Cotteswold tributaries of the Severn cut notches from the opposite direction in the escarpment. From both these causes, the Oolite does not show such a smooth boundary line on the geological map as does the Chalk. It is smoothest in North Lincolnshire, where the ridge is lowest (only about 200 feet). It is highest where it forms the fine range of the Cotteswold Hills, in Gloucestershire; and is well-marked in the Cleveland

Hills of Yorkshire ; but elsewhere it forms a somewhat broken mass of high ground. Railways can thus cross the Oolite ridge in many cases by river valleys, instead of dry valleys as is so often the case with the Chalk. The actual watershed, however, whether in the Oolite ridge or the Lias belt, must be tunnelled.

Stone-quarrying.—Although it is principally along and near the escarpment that oolitic limestone occurs, yet beds of it also occur in some of the minor ridges of the Oxford-clay vale. That is why the whole of this belt is coloured one colour and called “Oolites” on the geological map. The oolitic limestones usually make excellent building-stone, easily shaped by cutting with a saw.

Famous places for building-stone are the **Isle of Portland**, Ham Hill near Yeovil, Chilmark in the Vale of Wardour, Douling near Wells, the **Bath** district, Minchinhampton near Stroud, the Cheltenham district, Barnack in Northamptonshire, Ketton in Rutland, and Ancaster in Lincolnshire. All these places give their names to the stone quarried there, which is not only used locally for building, but sent in large quantities to other parts of the kingdom. It is only some layers that are good stone, but the inferior layers must be dug out too, so these are used very largely for rough walls, and a characteristic feature of the Oolite belt is the use of stone walls as field-boundaries instead of hedges, not merely in the bleak uplands where hedges would not grow well, but even in the sheltered fertile valleys.

At Stonesfield near Oxford and Collyweston near Stamford another kind of stone occurs which splits into thin slabs, and was formerly much used for roofing houses ; but since railway carriage has made it possible to bring the much thinner-splitting Welsh slates everywhere, these quarries are almost abandoned, except when stone is wanted to repair the roofs of old buildings such as the Oxford colleges, which are roofed with Stonesfield slate.

Iron-mining.—Here and there in the Oolite and Marlstone ridges, deposits of valuable iron ore occur, and blast-furnaces

have been set up to smelt it. The chief of these are at Westbury in Wiltshire, at Kettering, Wellingborough and many other places in Northamptonshire, and in the Cleveland hills of Yorkshire. In the last district the large town of **Middlesbrough** has grown from a mere village since the establishment of the iron industry.

Cattle and leather.—As has been seen already (Lesson IX.) the soil in the highest parts of the Oolite ridge is thin and supports only short grass for sheep-grazing. In the valleys it is thicker and forms good arable land, especially suitable for turnips, barley and wheat. Here, as in the Oxford-clay belt, much old arable land has been turned into grass. This is particularly the case in Northamptonshire, where the change took place in the eighteenth century, since which time the county has been famous for cattle-grazing. Though it is now beaten by other counties in this respect, it still has one-third more cattle in proportion to its area than the average of England. Now, cattle yield not only milk and meat, but also hides, which by tanning make leather, and **Northampton** has long been the centre of the boot and shoe-making industry, which is dependent on leather. Along the Nen valley we find, besides Northampton itself, smaller towns such as **Wellingborough** and Higham Ferrers, and many manufacturing villages, in all of which boot-making is the staple industry, or shares that position with iron-mining and smelting.

LESSON XIX.

THE RED PLAIN.

1. On an outline county map of England and Wales sketch in and shade the areas occupied by New Red Sandstone (see p. xiv). Then indicate on each county the amount of salt and gypsum raised there—a cross for every 100,000 tons (or fraction thereof) of salt, and a dot for every 10,000 tons of gypsum.

OUTPUT OF SALT AND GYPSUM, 1907.

	Salt.	Gypsum.
	1000 tons	1000 tons
Cheshire and Staffordshire - -	1,275	50
Lancashire - - - - -	283	0
Durham - - - - -	159	0
Worcester - - - - -	173	0
York - - - - -	28	0
Nottingham - - - - -	0	96
Cumberland - - - - -	0	36
Sussex - - - - -	0	28
Derby - - - - -	0	7
Westmorland - - - - -	0	4
Somerset - - - - -	0	2

What is the exception to the rule that salt and gypsum are only found in Britain in workable quantities where there is New Red Sandstone ?

2. Calculate the percentage of the total production of salt and of gypsum in each producing county, and express the results by two diagrams.

3. On an outline map of England and Wales sketch in from the geological map the chief areas of Coal Measures (coal-fields), and shade them lightly in pencil. Leaving out of account places where the geology is intricate, draw a distinct black line as boundary wherever the Coal Measures come against the formations named Millstone Grit and Carboniferous Limestone ; but leaving only an undefined boundary where they come against New Red Sandstone. The two former are rock-formations which rise up to the surface from *beneath* the Coal Measures ; the two latter rest upon and cover either Coal Measures or other formations. Bearing these facts in mind, find regions on your sketch-map on which you can safely write either "There is no coal below here," or "Coal may possibly be found below here" ; and write accordingly.

4. By reference to the geological map, make a list, in tabular form, of the rivers in England and Wales which run for an important part of their course along the New Red Sandstone and Lias.

5. By reference to the geological map of the British Isles make a list of the railways between important towns which run for all or nearly all their course along the New Red Sandstone and Lias.

New Red Sandstone.—By whatever railway a journey is made that has to cross the main watershed of England, soon after this has been passed a region is reached where redness is a general feature—the railway cuttings are in red rocks, the soil of the ploughed fields is red, the buildings are of red stone, the sea-cliffs are red. The region characterized in this way is represented appropriately on the geological map by a light red tint, which has its widest extent in the very centre of England, in the Birmingham district. Thence it extends in three directions: one broad band runs out to the sea in Cheshire and along the west coast up to Morecambe Bay; a second on the east side running up to the mouth of the Tees; a third, much narrower and not quite continuous, down the lower Severn and across the country to the mouth of the Exe. These red rocks are known to geologists as the **Permian** and **Trias**. As they consist very largely of sandstone they are also termed the **New Red Sandstone** to distinguish them from the **Old Red Sandstone**, the difference being this—that when these two series are found in the neighbourhood of the coal-bearing rocks (Coal Measures), the New Red may be seen to lie on the top of these, while the Old Red may be found beneath them.

Coalfields.—Imagine a door which has had three coats of paint, the first red, the second green, and the third red again; then by exposure to the sun the whole has been blistered and chipped. All three coats would show in places, as well as the bare wood; but it would always be possible to distinguish the two reds, because the green comes between, although a blister might often push the old red farther away from the wood than the new red was elsewhere. Just so with the rocks: the Old Red and the Coal Measures (represented by the green paint) have been, as it were, blistered up to heights far above sea-level, while the New Red lies comparatively low; but whenever they come together, the others pass beneath the New Red and

not over it. It is only in South Wales and Scotland, however, that there is any Old Red.

The geological map shows in the Midlands a number of "blisters" where coal-bearing rocks protrude through the New Red. Here there is high ground, part of the main watershed of England. From this high ground flow tributaries to the Severn and Trent whose course is along two of the arms of New Red Sandstone. The third arm is occupied by the Dee, the Weaver and the Mersey.

The great red plain.—It must be understood that the name "New Red Sandstone" is given only in a general way. Quite half the area is not sandstone at all but red marl, a sort of clay. Then the surface is in many places covered with glacial deposits like those of East Anglia (not shown on the geological map) and along the course of the main rivers with alluvial deposits (only shown where they become very extensive, as in Somerset and on both sides of the Humber). Lastly, so much of the Lias belt as lies west of the main watershed cannot be separated from the red plain, though its soil is mainly clayey, with some limestone-beds. Even the Lias soil is sometimes red, as in Rutland (meaning red land).

Though parts of the red plain, in the heart of England, attain a height of 700 feet above the sea, and there are many minor ridges and steep escarpments, the general feature of the New Red area is openness and ease of communication. It affords some of the most important and easy routes for travelling. The following main lines of railway lie almost entirely within it :

(1) The London and North-Western main line from Rugby to Lancaster—part of the western route from London to Scotland.

(2) The Great Northern and North-Eastern from Grantham to York and Darlington—part of the eastern route to Scotland.

(3) The original Midland Railway from Rugby to Derby and Nottingham (the portion between Rugby and Leicester is not now a main line).

(4) The Great Central line, which also runs from Rugby to Nottingham.

(5) The Great Western line from Leamington through Birmingham and Shrewsbury to Chester.

(6) The Midland line from Derby through Birmingham and Gloucester to Bristol.

(7) The Great Western line continuing the last from Bristol to Exeter and Torquay.

LESSON XX.

THE CENTRE OF ENGLAND.

1. Examine Fig. 39. What is the scale of the map? What are its dimensions from north to south and from east to west? What area does it represent?

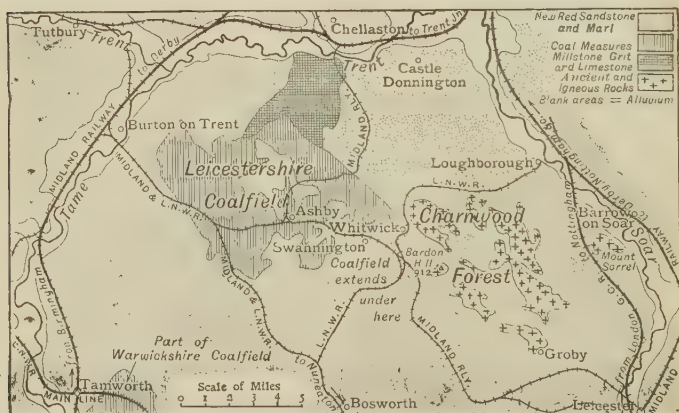


FIG. 39.—GEOLOGICAL MAP OF THE LEICESTERSHIRE COALFIELD AND CHARNWOOD FOREST.

Draw on a card a rectangle representing the area of this map on the scale of 25 miles to an inch; cut out this rectangle and fit the card as a mask on the part of Fig. 43 (p. 113) which represents the same region.

2. What rivers come within the area of Fig. 39? Which is the main stream and which are the tributaries? What is the

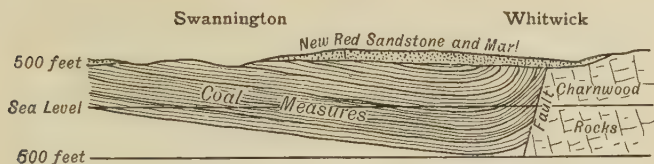


FIG. 40.—SECTION ACROSS PART OF THE LEICESTERSHIRE COALFIELD AND OF CHARNWOOD FOREST.

Horizontal Scale—1 inch to a mile. Vertical Scale—nearly 3 inches to a mile.

nearest statement you can make as to the altitude of these rivers above the sea (by reference to Fig. 43)? Note the height of Bardon Hill—the highest point within the area?

3. What rock-formation occupies most of the area? What formations occupy the main part of the high ground, and which (apart from alluvium) comes nearest to the rivers? Refer to the section, Fig. 40, and state which of these formations overlies the others?

4. Compare the courses of the main and branch railways on the map. Which cross the high ground? Which follow the valleys? Which have the straighter courses?

5. Examine Fig. 41. What is the total thickness of rocks passed through in this boring? What is the thickness of the thickest coal-seam passed through? The total thickness of all the coal-seams? What percentage is this of the total thickness of rock? Measure the length of the Leicestershire coalfield from N.W. to S.E. (as far as the word *here*), and breadth from N.E. to S.W. through Ashby. Assuming the coalfield to be a rectangle with these dimensions, that the seams of coal shown in Fig. 41 and

Depth in Feet.

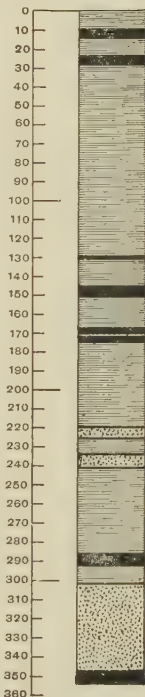


FIG. 41.—SECTION OF STRATA PASSED THROUGH IN A COAL-SHAFT IN THE LEICESTERSHIRE COALFIELD.

Black, coal; lines, shale; dots, sandstone.

Scale—1 inch to 100 feet.

no others extend over all this area, and that a cubic yard of coal weighs a ton, calculate how many tons might be raised from the coalfield.

The actual amount raised in 1906 was 2,316,510 tons. At this rate, for how many years would the coal supply last?

In reality there are about 25 seams, with a total thickness of 90 feet, but they do not all extend over the whole area. Coal has been dug here since the thirteenth century at least.

6. The igneous rocks of Charnwood Forest lie in Leicestershire: What percentage of Great Britain's total production of such rocks does that county produce? What is the percentage of the county with the next largest production? Represent these facts by a diagram like Fig. 13 or Fig. 14. What is the average price of a ton of igneous rock in Leicestershire? How does this compare with the average of Great Britain, and with that of Cornwall, Aberdeenshire, Shropshire and Pembroke?

Igneous Rocks are rocks that have been formed by cooling from a molten condition, like a volcanic lava. Some of these rocks are valuable as building-stones (*e.g.* granite), others are useful for the making and repairing of macadamized roads (road-metal).

OUTPUT OF IGNEOUS ROCK, 1907.

	Quantity.	Value.
	1000 tons	£1000
Cornwall - - - -	251	£76
Leicestershire - - - -	1,237	282
Northumberland - - - -	234	41
Shropshire - - - -	321	53
All other English Counties -	1,058	184
Carnarvonshire - - - -	613	168
Pembrokeshire - - - -	628	17
All other Welsh Counties -	104	15
Aberdeenshire - - - -	238	113
Lanarkshire - - - -	216	40
All other Scotch Counties -	991	180
Total, Great Britain -	5,891	£1,169

Charnwood Forest.—In travelling down the Soar valley between Leicester and Loughborough (a part of the red plain), the even-topped Marlstone hills (Lesson XVIII.) are seen in the distance on the right, but on the left are heights of a much more rugged character—the hills of Charnwood Forest. If the latter are examined close at hand, they are found to be made of very hard rocks, some slaty, some like granite—such as are found nowhere else nearer than the borders of Wales. To apply the analogy of the painted door to this district, the green and the old red coats must be supposed to have been chipped away before the second red coat was applied, and some splinters of the bare wood must be imagined to be sticking up with a single coat of paint worked around and among them. There is, in fact, in Charnwood Forest, a strange mixture of two types of scenery—bits of bare, bleak moorland, where the hard **ancient rocks** rise up, and wooded valleys with a rich red soil in between. One important result of this is that the streams fed by the heavy rain on the high ground run in broad valleys over the red rocks, and contract into narrow gorges, where they strike on a ridge of hard rock. Such valleys are well suited for water-reservoirs: by building a stone dam across the narrow gorge a wide lake is formed in the valley behind. Leicester and Loughborough are supplied with water in this way.

Some of the granitic rocks are valuable as road-metal, and enormous quantities are exported by rail to various parts of England. Immense hollows at Mount Sorrel, Bardon Hill and Groby show the importance of this product, which fetches a good price compared with most other road-stones, though much less than that of similar rock suitable for building-stone.

Leicestershire coalfield.—On the western side of Charnwood Forest there is an abrupt change, concealed under the red marl. Modifying the former comparison it may be said that here a layer of red paint conceals the junction of two pieces of totally different woods. The rocks that rise up from under the red marl to the west and occupy the rest of the high ground between the Soar and the Trent are what are called the **Coal Measures**, because they contain coal. Fig. 41 gives an idea

of the nature of these rocks and the proportion which coal forms of the whole thickness. Beds or **seams** of coal, as they are called, vary in thickness from a fraction of an inch up to 30 feet, but are not worth extracting if less than about a foot thick. In the Leicestershire coalfield there is a seam 12 feet thick, and many others from 3 to 9 feet. Some of the coal when examined microscopically shows vegetable structure, and from this fact and the frequent occurrence in the Coal-measures in various coalfields of stumps of tree-trunks and roots (Fig. 79, p. 248), it is known that coal is the remains of an accumulation of plants long dead, something like the more modern peat that will be described presently (pp. 143, 295).

The Leicestershire coalfield shows the characters of a coal-country in the simplest form, because it produces little else but coal—the only other important productions being pottery and drain-pipes from the clayey beds of the Coal-measures. The sites of the mine-shafts are marked by the huge wheels that wind up the **cage** that carries the miners and their coal. The miners live in villages, because mines cannot be concentrated like factories in one place, and the only towns that are to be found in this coalfield are market-towns, such as Ashby-de-la-Zouch, which existed as such before coal-mining began. A very different state of things is seen where manufacturing industries are situated on coalfields.

Much useless rock has to be extracted with the coal, and this is thrown or “tipped” a little away from the mouth of the shaft. These **tips** or **spoil-heaps** form one of the characteristic features of all mining districts. Where fresh material is not continually being added, they soon become covered with vegetation; but fresh tips in a coal-mining district are black and ugly.

Railways to convey away the coal are a necessity in a coal-mining district, and the earliest railways made were for this purpose. On this coalfield the Leicester and Swannington railway was opened as early as 1832, to convey the coal to the canal at Leicester. Other railways have since been made connecting the coalfield with Nuneaton, Burton and Derby;

but the limited output of this coalfield has not justified the extensive network of lines that is seen in other coalfields.

Warwickshire coalfield.—A few miles to the south-west, between the valleys of the Tame and its tributary the Anker, is another coalfield, called the Warwickshire coalfield (though partly in Staffordshire), extending from Tamworth to Nuneaton. On the eastern border of this, as on that of the Leicestershire coalfield, ancient rocks rise up, and there are very large quarries for road-metal at Hartshill, near Nuneaton. A few miles south of this coalfield and over the watershed on the slope to the Warwickshire Avon, stands the ancient town of **Coventry**, at one time noted for silk-weaving and watches, but now a great manufacturing centre for **cycles** and **motor-cars**.

LESSON XXI.

THE BLACK COUNTRY.

1. Examine Fig. 42. What is the scale? What area in square miles do the three maps each represent? Find the corresponding area on Fig. 43, and find from that what main river-basins are separated by the watershed line in Fig. 42.

2. Measure the direction and distance of the following places from Birmingham (B.): Stourbridge (Sb.), Wolverhampton (Wv.), Walsall (Ws.), West Bromwich (W.B.), and Tamworth (Tm.).

3. Find the latitude and longitude of Birmingham.

4. Make lists of the places having over 5000 inhabitants, arranged in order of population, on or within 5 miles of (a) the South Staffordshire coalfield, (b) the Warwickshire coalfield. Measure the areas of the two coalfields so far as they are shown on the map. Which has the denser population? In which direction respectively is each of these coalfields likely to have an underground extension beyond the limits shown?

5. Examine the railway-map and trace the course of the following lines, continually referring to the orographical and geological maps. State which of these lines, for a large part of

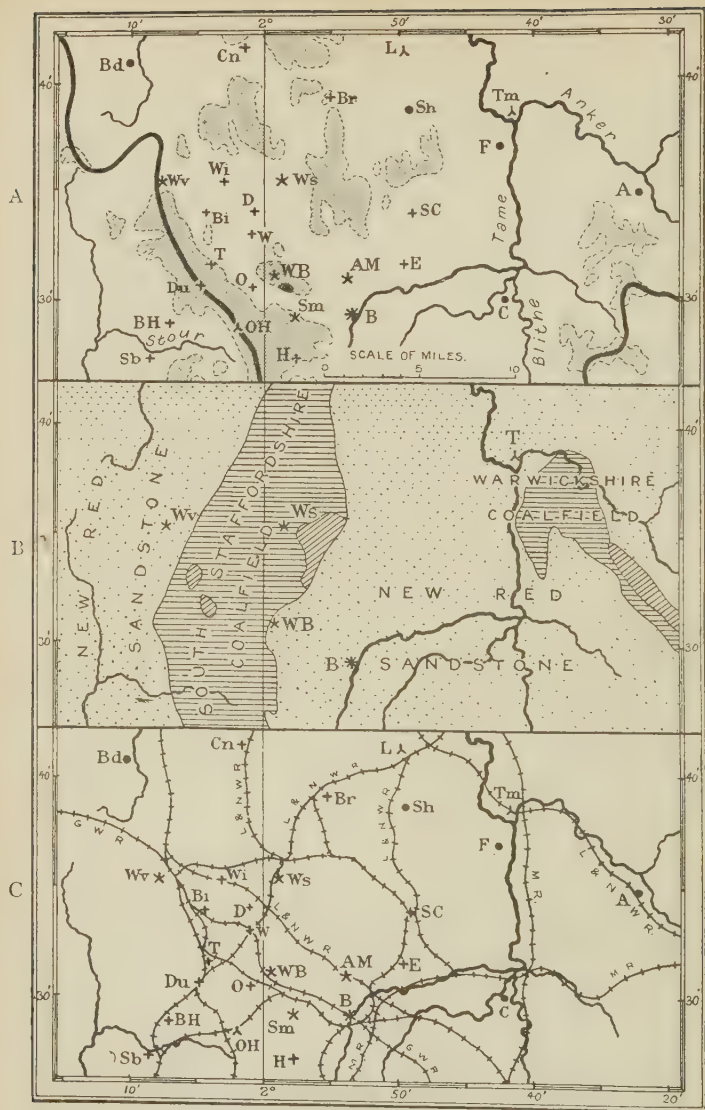


FIG. 42.—MAPS OF THE BLACK COUNTRY.
 A, orographical (shaded area above 500 feet); B, geological; C, railway.
 The oblique lines on B denote ancient rocks.

their course, (a) follow a river-valley, (b) keep a nearly level course near a watershed :

L.N.W.R. main line from London to Crewe, passing through Atherstone (A.) and Tamworth (Tm.).

L.N.W.R. from Birmingham to Stafford, through Aston (A.M.), Willenhall (Wi.) and Wolverhampton (Wv.); and through Smethwick (Sm.), Oldbury (O.), Tipton (T.) and Wolverhampton.

G.W.R. from London to Chester, through Birmingham, West Bromwich, (W.B.) Wednesbury (W.), Bilston (Bi.) and Wolverhampton.

M.R. from Bristol to Derby, through Birmingham and Tamworth.

6. Make percentage diagrams from the three columns below, uniting together as a single division all those occupations in which the percentages of both Staffordshire and Warwickshire do not differ by more than 5 from that of England and Wales.

THE CHIEF OCCUPATIONS OF STAFFORDSHIRE AND WARWICKSHIRE.

	PERCENTAGE OF TOTAL OCCUPIED PERSONS IN		
	Staffs.	Warwick.	England and Wales.
Making Metals and Machinery - -	20	24	9
Mines and Quarries - - - -	11	3	6
Brick, Cement, Pottery, etc., making	9 ¹	1	1
Domestic Service - - - -	9	11	14
Transport - - - - -	7	8	9
Supply of Food, Lodging, etc. - -	7	7	8
Building and Constructive Work -	6	7	7
Supply of Dress of all kinds - -	6	7	8
Working in Precious Metals, Watch- making, etc. - - - - - }	1	5	1
All other Occupations - - - -	24	27	37

The Black Country.—Of far greater importance than the coalfields already mentioned is the South Staffordshire coalfield, farther west in the same district. Its importance is due

¹ Mainly in North Staffordshire, not in the Black Country.

to the fact that the coal-measures here contain a deposit of valuable iron-ore, which from its occurrence in layers alternating with coaly matter is known as **blackband ore**. The smelting of iron and the making of iron goods is an old-established industry here; not so ancient as that of the Weald, but already doing an extensive trade four hundred years ago, long before the use of coal in iron-smelting was general.

The Forest of Arden, which lay to the south, furnished the charcoal then used, and to this day the chief manufacturing town, **Birmingham**, lies some miles off the actual coalfield. When coal came into use in iron-smelting, about 150 years ago, and the industry came to be carried on on a large scale, Birmingham relinquished the earlier and rougher processes of manufacture, and devoted itself to the higher branches of work in metals of all kinds, not only iron. Pins and needles, metal buttons, screws, tools, guns, and bedsteads, are a few of its innumerable products. With its population of over half a million, Birmingham is the largest city within a radius of 70 miles, and claims the title of "capital of the Midlands." An enterprising city, it has constructed fine streets through what was formerly the crowded and badly built central area, and, although possessing a good supply of water near at hand, has had the foresight to provide for its future needs by constructing great reservoirs in Wales (Lesson XXXIII.), from which it obtains its water by an aqueduct 100 miles long.

Coal, iron and bricks.—The other important towns of this district are situated on the coalfield itself. These are the great iron-smelting towns of **Wolverhampton**, **Walsall**, **West Bromwich**, **Dudley**, **Wednesbury** and **Bilston**, with many smaller industrial villages, all engaged in coal-mining or some branch of the iron industry. The whole district, high and bleak by nature, is blighted by smoke so as to be known as the **Black Country**. Dismal by day, it is rendered beautiful by night by the glowing furnaces brilliantly illuminating their immediate surroundings and leaving the farther darkness blacker by contrast.

In the neighbourhood of **Stourbridge** is found a valuable fire-clay, that is to say, clay free from the more easily melted

constituents of ordinary clays. The bricks made from this clay will stand intense heat, and they are therefore used for lining furnaces. Near Old Hill the clays of the Coal-measures, shaped into bricks and sprinkled with iron-dust before being fired, yield the **blue Staffordshire bricks**, which, though very durable, seem to carry the dismalness of the Black Country wherever walls are built of them.

Communication.—The Black Country lies in the heart of England, along the watershed between the Trent and the Severn. Birmingham is just equally distant from the ports of Bristol and Liverpool (about 80 miles in a straight line), while the Humber and the Thames estuary are each about 20 miles farther. Gloucester is the nearest port, but, as will be seen in Lesson XXVI., it has certain disadvantages; and even Gloucester is 50 miles away. This inland situation is a disadvantage for import and export, but there are canals and railways to lessen the disadvantages. One result is that Birmingham manufactures a large number of small valuable articles, to the cost of which the addition of a relatively heavy railway-rate is a trifle. Three railway systems pass through the district. The London and North-Western and Great Western run by different routes between Birmingham and Wolverhampton, both extending to London in one direction and to the Mersey in the other—the former by the Trent and Weaver valleys, the latter by the Severn and Dee, both being along the great red plain. The Midland crosses these on its way from Bristol and Gloucester to the north-east. A network of local lines joins to these main routes. It might be thought that the route to Gloucester would be easier than that to Liverpool, since the former has only to go downhill along the Severn slope, while the latter must cross another watershed. But the slope down to the Severn is very steep and includes the steepest incline on any main line of railway—the Lickey incline of three miles at 1 in 37; while the watershed in the red plain is so low as to be insignificant.

Another coalfield, that of Coalbrookdale, lies along the Severn Valley, west of the Black Country. Though now

nearly exhausted and of little importance, it is historically interesting, as here coal was first used for smelting iron; and the town of Ironbridge records in its name the construction in 1795 of a bridge of 100 feet span across the Severn—the first bridge built neither of wood nor stone.

LESSON XXII.

THE TRENT VALLEY.

1. What is the scale of Fig. 43? What are the dimensions of the map in miles? By means of squared tracing-paper determine the area of (*a*) the Trent basin, (*b*) the Don basin, (*c*) and (*d*) the approximate area above 500 feet high in each of these basins. Express the latter areas as percentages of the total areas.

2. Measure the length of the Trent. Make a list of the right- and left-bank tributaries named on the map, and measure their length. After you have done the work of section 4 below, add to this list a statement of the principal geological formation which each tributary drains.

3. Measure the distance and direction of each of the following places from Birmingham (B.), Stoke-on-Trent (S.-on-T.), and Nottingham (N.), and of these places from one another, and express the result in tabular form:

Stafford (Sf.), Manchester (M.), Sheffield (S.), Derby (Dy.), Coventry (Co.), Leicester (Lt.) and Newark (Ne.).

4. Make a mask to expose the Trent basin on the geological map of the British Isles. Compare the exposed part with Fig. 43, and make a sketch-map showing (1) Lias, (2) New Red Sandstone, (3) Coal Measures, (4) Carboniferous Limestone, etc., (5) Alluvium.

Name the coalfields (including the North Staffordshire or Potteries coalfield, which is not named on Fig. 38, but is marked on Fig. 73).

Which of these formations forms the most continuous high ground? Which form the most continuous low ground? Where and in what formation does the watershed reach its highest point?

5. Examine Fig. 44. What is the scale of the three maps? What area in square miles does each represent? Find the



FIG. 43.—BASINS OF THE TRENT AND DON.

The shaded areas are bounded by the 500 and 1000-foot contour-lines.

corresponding area on Fig. 43, and find what main river-basins are separated by the watershed-lines of Fig. 44.

6. Measure the direction and distance of the following places

D.G.

H

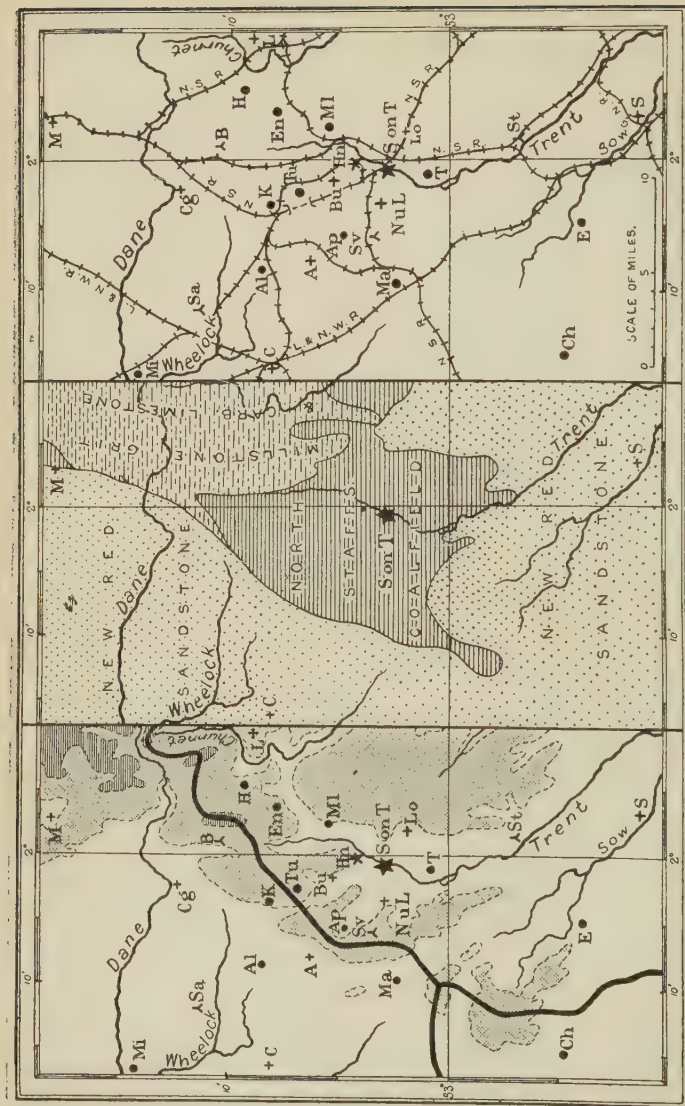


FIG. 44.—MAP OF THE NORTH STAFFORDSHIRE OR POTTERIES COALFIELD.
A, orographical (contours at 500 and 1000 feet); B, geological; C, railway.

from Stoke-on-Trent (S.-on-T.): Stafford (S.), Crewe (C.), Macclesfield (M.), and Leek (L.).

Examine the course of the Derwent within the shaded area. On which side does it receive longer tributaries? What is the average distance of the river from its watershed on the other side? What difference is there between the streams flowing eastwards and those flowing westwards from that watershed? What type of watershed does this appear to indicate? Refer to the geological map: What formation constitutes this watershed? On what formation does the Derwent principally flow?

The North of England.—The map of England shows that north of (approximately) the parallel of latitude 53° N., the island becomes suddenly narrower, as Wales on one side and East Anglia on the other are cut off. This narrow "North of England" is seen on the orographical map to have a mass of high ground as its **axis** or **backbone**, often called the **Pennine chain**, but better termed the **Pennine axis**. The geological map shows that this axis is formed of the rocks known as the **Carboniferous Limestone** and **Millstone Grit**, while for some distance on either side at its southern end lies a coalfield. The north of England may thus be associated in the mind with limestone, millstones (and grindstones) and coal.

The limestones and grits dip down east and west under the **Coal-measures**, and these dip in turn under the red rocks of the plain, so that coal is mined beyond the limits of the Coal-measures shown on the map. In fact it is not yet known how far underground the Coal-measures may extend in either direction; but it is hopeless to look for coal in the Pennine axis itself.

Southwards the Pennine axis ends off abruptly, also about lat. 53° ; so that there is altogether a very great difference between England north and south of that parallel. Here the two arms of the red plain meet in the centre of England, and here the **Trent** curves in a kind of semicircle round the end of the Pennine axis.

Tributaries of the Trent.—The main watershed of the North of England lies well on the west side of the Pennine axis, and

in the **Peak district** (as the southern part of that axis is called) the rivers all flow in a south-south-easterly direction, uniting into a main stream flowing east and then north along the centre of the red plain to the Humber. One of the most westerly of these streams has, of course, the longest course, and so is regarded as the main stream of the Trent: it flows through the North Staffordshire coalfield before emerging on the plain. Its principal left-bank tributary is the **Derwent**, which flows in a longitudinal valley at the foot of the Millstone Grit escarpment. This, with the parallel streams the Churnet and Dove, drains the limestone Peak district. The much shorter Erewash and Leen drain part of the coalfield on its eastern side; much farther north is the Idle, draining part of the red plain. On the other side, it receives the Sow, from the plain; the Penk and Tame (with its tributaries Anker and Blithe) coming from the Midland coalfields; and the Soar (with the Wreak) from the Marlstone hills to the south-east.

The Potteries.—The North Staffordshire coalfield lies on the rainy side of the Pennine axis. Here, about 150 years ago, Wedgwood founded the **pottery industry**, because the clays of the Coal-measures were very suitable for making china. The growth of the industry, as well as that of coal-mining, has led to the series of large towns existing so close together that, though called by separate names—**Stoke-on-Trent**, Hanley, Burslem, Newcastle-under-Lyme, etc.—they now really form one great town with a total population of 236,000. The whole district is spoken of as **The Potteries**. As is usually the case with a highly-developed industry, it no longer depends upon local raw materials for its productions. The local clays are now only used for the coarser kinds of earthenware, tiles, bricks and drain-pipes. For its finer porcelain and china-wares it imports the china-clay of Devon and Cornwall (Lesson XXIX.), and the pipe-clays of Poole (Lesson XIII.); while **gypsum** from the red marl of Chellaston, near Derby (Fig. 34), **chert** from the Carboniferous Limestone of the Peak and Flintshire, and **flints** from the chalk of the south of England are also used as ingredients. The district is not situated very favourably for

importation. Its nearest port is the Mersey, but in that direction the watershed rises in places to 700 feet and has to be pierced by tunnels a mile long at Harecastle, both for the railway and the canal.

LESSON XXIII.

THE TRENT VALLEY (*Continued*).

1. Which is the largest town within the Trent basin? Which are the three next largest? Where is the greatest cluster of towns? What counties lie wholly and what partly within the Trent basin? Which of them take their names from large towns within that basin? From small towns within it? From towns outside it?

2. Make a list of the chief towns in the Trent basin, arranged in order of importance (as shown by the population-symbols on the map), and write the approximate population against each.

3. Trace, as in previous lessons, the courses of the following railways, making use of any details learned from Lesson XXI.:

(1) L.N.W.R., from Rugby (Rb.), through Nuneaton (No.), Atherstone (Ath.), Tamworth (Tm.), Lichfield (Li.) and Stafford (Sf.) to Crewe (Cr.).

(2) L.N.W.R., from Rugby, through Coventry (Co.), Birmingham and Wolverhampton to Stafford.

(3) M.R., from Gloucester, through Birmingham, Tamworth, Burton-on-Trent (B.-up.-T.), Derby (Dy.), Belper (Bp.) and Chesterfield (Ch.) to Sheffield (S.).

(4) M.R., from Derby, to near Buxton (Bx.), to Stockport (Sk.) and Manchester (M.).

(5) M.R., from Wellingborough (W.), through Kettering (K.), Market Harborough (M.H.), Leicester (Lt.) and Loughborough (Lb.) to Trent Junction (near L.E.), and thence (a) to Derby; (b) to Nottingham (N.), Newark (Ne.) and Lincoln (L.); (c) through Ilkeston (I.) to Chesterfield.

(6) M.R., from Kettering to Melton Mowbray (M.M.) and Nottingham.

(7) G.N.R., from Grantham (G.), through Newark (Ne.) and Retford (E.R.) to Doncaster (Dc.).

(8) G.C.R., from Rugby, through Leicester, Loughborough and Nottingham to Sheffield.

(9) G.C.R., from Sheffield, through Retford to Grimsby.

(10) M.R., from Sheffield, through the Totley and Chinley (Cowburn) tunnels to Stockport and Manchester.

4. On an outline county-map of England sketch the geology of Derbyshire, Leicestershire, Nottinghamshire and Staffordshire.

All four counties contain large areas of New Red Sandstone and Coal-measures, and also of alluvium (not shown in the geological map) along the main rivers. Three of them are characterised by the presence of large areas of other rocks. Make a table to show the special geological and special agricultural features of each county, the latter being obtained from the table given below, by carefully noting those figures in which a county is much above or much below the other three.

Make also a list of agricultural features in which all four counties differ in the same manner from the average of England.

AGRICULTURE IN THE COUNTIES OF THE TRENT VALLEY, 1907.

County.	Per-centage of Total Area Cultivated.	Per-centage of Arable in Cultivated area.	Popu-lation per 1000 Acres.	Cattle per 1000 Acres.	Sheep per 1000 Acres.	Per-centage of Wood-land.	Percent-age of Heath and Moun-tain.
Derby -	75.7	18	936	220	218	4.0	5.5
Leicester -	89.3	20	820	270	572	2.7	0.2
Stafford -	80.5	26	1660	223	293	5.2	1.2
Nottingham -	82.8	51	953	161	335	5.7	0.3
All England -	76.0	44	876 E. & W.	156	458	5.3	7.3

PERCENTAGES.

County.	Clover, etc., on Arable.		Permanent Grass.		Mountain Pasture.
	For Hay.	Not for Hay.	For Hay.	Not for Hay.	
Derby - - -	4	1	28	54	7
Leicester - -	4	1	22	56	0
Stafford - - -	6	2	23	51	2
Nottingham - -	6	5	16	33	0
All England - -	6	4	17	39	9

Industrial county towns.—The Trent (after leaving the North Staffordshire coalfield) and its tributaries from the south flow through a part of the red plain which has as its chief characteristics :

- (1) a fertile soil and moderate rainfall ;
- (2) ease of communication in all directions ; and
- (3) plentiful supplies of coal near at hand.

These are suitable conditions for prosperous agriculture and industry, but not the conditions that lead either to the rapid growth of entirely new towns like Middlesbrough, or to the close clustering of many towns, as in the Black Country or the Potteries. The industrial towns here are mostly very old towns, often county-towns chosen originally as such for strategic reasons in the days when English and Danes were disputing the mastery of the land. Such are **Leicester**, **Nottingham**, **Derby** and **Stafford**, each of which gave its name a thousand years ago to an English shire.

These four counties may be taken as corresponding fairly closely with the Trent basin. Except that the Tame drains part of Warwickshire and that the last part of the Trent's course lies in Lincolnshire, the correspondence would be very close. It is of interest, therefore, to take some of the agricultural returns for these counties, and compare them with those of England as a whole and the Eastern Counties. The comparison shows that the proportion of cultivated land is up to or above the average ; but of this the proportion that is in permanent grass is far higher than the average (about 50 per cent.) except in Nottinghamshire, where the arable is slightly in excess of the grass-land. This high percentage of grazing land may be associated with the wide stretches of alluvium bordering the meanders of the Trent and some of its tributaries, and it is not surprising to find that (again with the exception of Nottinghamshire) the number of cattle is above the average for the area. Much milk is sent from this region to Birmingham and London daily. Nor is it surprising to find the boot-making industry at Leicester and Stafford. Leicester-shire alone among these counties includes a part of the Oolite

ridge, and therefore has a high percentage of sheep, and this may perhaps be associated with the **hosiery** industry of **Leicester**, though wool is not the only material of which stockings are made. The town dates from Roman times, being situated where the Roman road from Exeter to Lincoln crossed the Soar.

Stafford is a small town on the Sow, where there is some boot-making, and an important railway-junction. **Lichfield**, a few miles away from the river, is a quiet cathedral-town, near the crossing of two Roman roads, which gave it importance in early times. Tamworth and Nuneaton have already been referred to (p. 107). At **Burton**, the water contains much gypsum dissolved from the red marls, and is therefore very good for **brewing**. Here are the largest breweries in the country, which dispatch several train-loads of beer to London daily.

Derby is situated where the Derwent emerges on to the plain. Once an important strategic point, as commanding the Derwent Valley, it is now (like so many other old strategic places) a great railway-junction, the headquarters of the Midland system, and the site of great locomotive- and carriage-building works. **Nottingham** is built on a soft red sandstone much excavated into caves at a place where a high precipitous rock commands a view over the Trent Valley, and was chosen as the site of a castle. Here are manufactured cycles and motor-cars, hosiery and lace, and lace-making machinery. A row of large hosiery-making villages extends from Nottingham to Mansfield.

House-coal and building-stone.—We are here on the borders of the largest coalfield in the country, from which great quantities of household coal are sent by rail to London. Half of the coal burnt in London is said to pass through the large coal-sidings situated near Trent Junction, halfway between Derby and Nottingham. The Erewash valley railway (part of the Midland main line) taps this coalfield and extends across the watershed at Clay Cross to the Hipper Valley and the Don; but, as in other coalfields, there is a network of lines.

A striking feature of the geological map is a streak of blue running due north from Nottingham to Durham and appearing

nowhere else. This marks the outcrop of a thick series of beds of Magnesian Limestone (carbonate of calcium and magnesium), the harder beds of which are quarried at various places for building-stone, paving and road-metal. This was the stone selected for building the Houses of Parliament at Westminster.

The course of the Trent below Nottingham is through an agricultural district, past the old fortress and market-town of Newark and into Lincolnshire—a county which requires a lesson to itself.

LESSON XXIV.

LINCOLNSHIRE.

1. Examine Fig. 45. Why have different contour-lines been chosen from those in most of the other maps? Measure the area of the Witham basin. Measure the length of the Witham in three sections, (*a*) where it flows northward, (*b*) eastward, (*c*) south-eastward.

2. What is, as near as you can state it, the altitude of the watershed between Trent and Witham, from lat. $52^{\circ} 55'$ N. to lat. $53^{\circ} 25'$ N.? What is the height of the Lincolnshire uplands within the same limits?

How many wind-gaps and how many water-gaps does the map show in the uplands? What towns stand in or near these gaps?

3. Examine and compare Figs. 46 and 47. What is there unusual about the way the cardinal points are placed in Fig. 46? Why has this been done? In what direction do the Wey and the Witham respectively flow through the gaps at Guildford and Lincoln? Estimate the altitudes above the sea of these rivers where they flow through the gaps. The Wey has about 12 miles to flow before joining the Thames some miles above the tide-limit; the Witham has about 35 miles to flow to the Wash—which is the slower-flowing stream?

4. Measure the least width of each gap, measuring at a level rather less than 100 feet above the river-level. How many railway-lines converge from each side of each gap? Into how

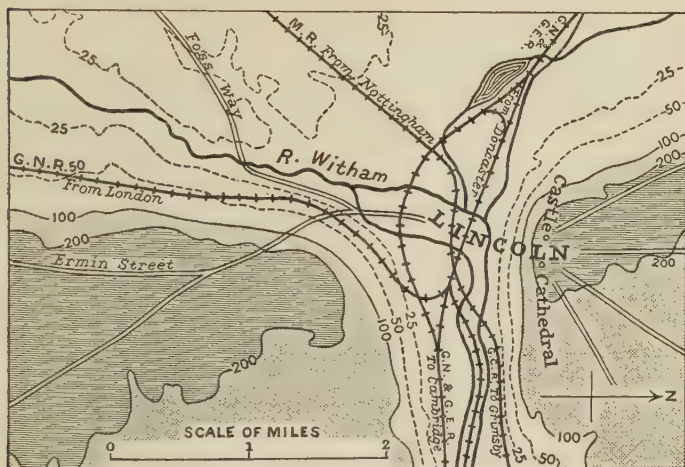


FIG. 46.—THE SITE OF LINCOLN.

The numbers on the contour-lines give their altitude above sea-level in feet.

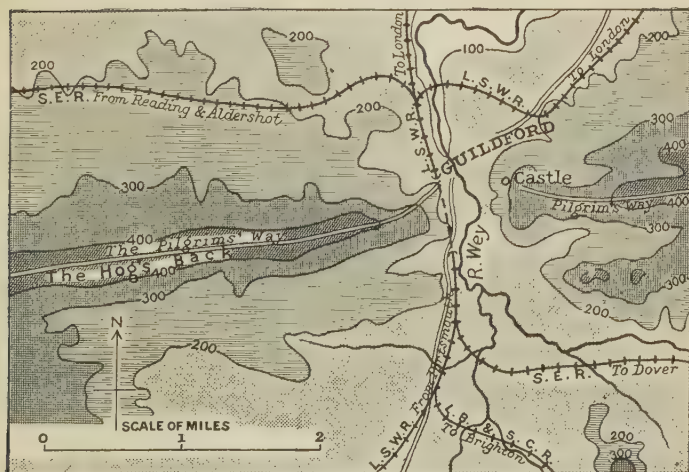


FIG. 47.—THE SITE OF GUILDFORD (SURREY).

The numbers on the contour-lines give their altitude above sea-level in feet.

5. Draw up a list of the points of resemblance and difference between Guildford and Lincoln.

6. Compare graphically, or otherwise, the proportions, both by weight and value, of the different kinds of fish landed at Hull, Grimsby, and Boston, with those landed on the whole east coast.

What is the average value per cwt. of the two chief classes of fish in each case where calculation is practicable?

EAST COAST FISHERIES.

	WEIGHT OF FISH.		VALUE OF FISH.		
	Caught in nets.	Caught by trawl and line.	Caught in nets.	Caught by trawl and line.	Total, including Shellfish.
	1000 cwt.	1000 cwt.	£1000	£1000	£1000
Hull - - - -	1	1,621	0	846	847
Grimsby - - -	303	2,641	129	2,312	2,450
Boston - - - -	0	113	0	99	107
Rest of East Coast from } Berwick to Dover }	2,738	1,642	1,016	1,456	2,655
Total, East Coast -	3,042	6,017	1,145	4,713	6,059

7. Make a tracing, from Figs. 38 and 40 in combination, of the area lying between longitudes $0^{\circ} 30'$ E. and $1^{\circ} 30'$ W., and between latitudes $52^{\circ} 20'$ and $53^{\circ} 45'$ N., omitting the shading and watershed lines. By reference to Bartholomew's *Touring Atlas*, mark with a red dot the approximate position of all places the names of which have the Danish terminations *by* or *thorpe*, and with black dots all those with the English terminations *ham*, *ton*, *borough*, *field* and *well*.

Lincolnshire may be defined roughly as the land lying between the Trent on the west and the sea from the Humber to the Wash on the east. It resembles East Anglia in position, in the absence of high ground, in rainfall (about 25 inches annually), and in its high proportion of cultivated land. But it contains within itself a series of belts of rock which farther south spread over a far greater width—New Red Sandstone, Lias clay vale, Oolite ridge, Oxford clay vale, Chalk ridge and Fen-alluvium. The two ridges are low—the Oolite ridge,

known as the **Lincoln uplands** or the **High Dyke**, runs due north, its crest sinking from 450 feet in the south to only 200 feet in the north; the Chalk ridge, forming the **Lincolnshire Wolds**, attains 550 feet at one point near Claxby, but elsewhere varies between 300 and 500.

Fenland almost encircles Lincolnshire. In the south a large part of the Fens of the Wash belong to this county. A belt from 1 to 5 miles wide, extends all along the coast to the Humber, excepting only for one point, **Cleethorpes**, where the bare chalk comes to the sea and a popular watering-place has been established. Another favourite holiday resort is **Skegness**, on the alluvial belt. The alluvium is continued along the Humber to the mouth of the Trent, beyond which it expands into an immense area, second only to the Fenland of the Wash. Much of this lies in Yorkshire, but out of the Lincolnshire portion (though west of the Trent) there rises a low island of red marl, the **Isle of Axholme**. The fenland, originally a marsh, has long been drained, and now produces abundantly potatoes, turnips and other root-crops.

The chief river of Lincolnshire is the **Witham**, the basin of which forms the nucleus of the county. Its course is peculiar. Rising in the Oolite ridge in the south, it flows north along the Lias, parallel to the Trent, which is distant only 4 miles at Newark, the watershed between being very low and indefinite. When the Trent is in high flood, its water may overflow the watershed and unite with the Witham. Near Lincoln it is joined by a tributary from the north, also flowing near and parallel to the Trent, but in an opposite direction. The Witham then turns abruptly east, through a broad gorge across the Oolite ridge, and flows south-south-east to the Wash.

Water-gap towns. The gorge determines the site of Lincoln. The Romans took their main road from London to York along the Oolite ridge and founded their colony of Lindum (*Lindum colonia*, hence Lincoln) on the height overlooking the gorge, in which the road crossed the Witham. Here a Roman gateway still stands, and here are the mediaeval castle and cathedral;

but the town now extends down the steep side of the gorge and halfway across its floor, where are the railway-stations. The situation is much like that of Guildford, as a comparison of Figs. 41 and 42 will show; but the gorge here is wide enough to admit of several separate railway-lines with no need of tunnelling. Further, while the gorge of the Wey connects two parts of Surrey, in both of which there are large tracts of barren sandy ground, Lincoln is the centre of rich agricultural tracts; and again it is only 25 miles from a coalfield instead of 80. Thus, while Guildford has remained a small market- and county-town, Lincoln has become a city of 50,000 inhabitants, the chief centre of the manufacture of **agricultural machines** and appliances.

Other Towns.—Gainsborough is a smaller town, on the Trent, with similar industry to Lincoln; but the rest of the inland towns are simple market-towns, of which Louth, on the eastern slope of the Wolds, is the largest. A valuable bed of iron-ore is mined in the Lias at Scunthorpe and Frodingham near the Humber, and there are large blast furnaces and steel-rolling mills there. Of the ports, **Boston** at the mouth of the Witham was once of much importance, and still does some trade across the North Sea, but the silting-up of the Wash has prevented its growth in modern times. The chief port is **Grimsby**, which does a great trade with Hamburg and the Baltic, but is most noteworthy as a great **fishing-port**. It shares with Yarmouth and Hull the landing of fish from the Dogger Bank, but not, as at Yarmouth, fish caught in nets, but chiefly cod, whiting and haddock—fish which are caught by hook and line and kept alive until wanted for market—as well as flat-fish (plaice and soles) caught by trawling (*i.e.* dragging a net along the sea-bottom). So great are the quantities of fish landed at Grimsby that every day train-loads of them are dispatched to the markets of London, Lancashire and Yorkshire, and smaller quantities all over the country.

Lincolnshire is the largest county in England except Yorkshire, and three portions of it which have long been

distinguished are now recognized as separate administrative counties, that is to say each has its own county council. These are (1) Holland, the fen-district of the south, (2) Kesteven, enclosed by the great loop of the Witham, and (3) Lindsey, the rest of the county.

A large-scale map shows that a great number of place-names in Lincolnshire end in "by." This is a Danish word meaning town or village, and shows us how thickly the Danes settled here a thousand years ago.

LESSON XXV.

THE SEVERN BASIN.

1. Examine Fig. 48. Take a tracing of the boundaries of the Severn basin on squared tracing-paper, and determine the area of the basin in square miles.

2. With the tracing-paper resting on the map, sketch in the minor watershed line which separates the Teme and its tributaries from the main Severn basin.

In drawing this, bear in mind that every indentation of high ground by lower ground is a valley, whether a stream is shown in it or not: the line must therefore not be drawn across such an indentation. Where two indentations come from opposite directions the line may be drawn between them; and where a saddle of lower ground separates two areas of higher ground, the line may be drawn across it. The chief difficulty in a map with so few contour-lines as this lies in the difficulty of telling a pass or saddle from a continuous valley.

What two towns stand on or near to this minor watershed? Write a short statement of its course, mentioning the names of the hills which form part of it and the direction it takes at different parts of its course. Repeat this for the main watershed.

3. Make a mask to expose the Severn basin on the geological map. With this as guide, make a geological sketch-map of the Severn basin, distinguishing only (1) Ancient and



FIG. 48.—THE SEVERN BASIN.
The contour-lines are at 500, 1000 and 2000 feet above sea-level.

Igneous rocks, (2) Old Red Sandstone, (3) Coal-Measures, (4) New Red Sandstone, (5) Lias, (6) Oolites.

4. Make a list of the right-hand and left-hand tributaries of the Severn, stating against each the geological formations it drains, and the chief towns on its course.

5. Measure and tabulate the directions and distances of the following towns from Shrewsbury, from Worcester and from Gloucester, and of those three from each other: Hereford (Hf.), Oswestry (Os.), Stafford (St.), Birmingham (B.), and Stratford-on-Avon (S.-on-A.).

6. Make a sketch-map showing the course of the following railways, and write a brief account of each.

(1) M.R., from Gloucester (G.), through Cheltenham (Ch.), Worcester (W.), Droitwich (Dr.), Bromsgrove (Bg.) and King's Norton (K.N.) to Birmingham (B.). There is a very steep incline on part of this line: where is it most likely to be?

(2) G.W.R., from Gloucester, through Ledbury (Ly.) and Malvern (M.) to Worcester. There is a tunnel on this line: where is it most likely to be?

(3) G.W.R., from Oxford (Ox.) through Moreton-in-the-Marsh (M.M.), Evesham (E.), Worcester, Bridgnorth (Bn.), to Shrewsbury (S.), with a branch to Kidderminster (K.), Stourbridge (Sb.), Dudley (D.), and Wolverhampton (W.).

(4) G.W.R., from Oxford, through Banbury (Ba.), Leamington (Ln.), Warwick (Ww.), Birmingham, West Bromwich (W.B.), Wolverhampton (Wv.), Shifnal (Sh.) and Wellington (We.) to Shrewsbury.

The Severn.—Returning now to the Black Country, and following the red plain to the south-west instead of the north-east, the basin of the Severn is reached. This river rises among the Welsh mountains, not 15 miles from the Irish Sea, and after a fairly straight course to the north-east for about 35 miles emerges on the broad plain of North Shropshire, where it **meanders** about like a river approaching its mouth. Turning its course to the south-east, a change takes place: it enters a narrow **gorge** near **Coalbrookdale** and, flowing due south, resumes the character of an upland river. It emerges a second time into a **plain** near **Worcester**, after which it gradually turns its meandering course to the south-west and broadens out into

the **Bristol Channel**. Its chief tributaries may be seen from the map. The only one needing special mention is the Warwickshire Avon, which bears to the lower Severn much the same relation that the Kennet bears to the lower Thames, that is to say, it forms the straightest continuation of its lower course, and, like that, flows parallel to the Oolite escarpment.

The Severn in its great curve round forms a waterway from the Bristol Channel into the heart of England and North Wales. Its watershed sinks to about 250 feet above sea-level near Market Drayton in North Shropshire, where the headwaters of its tributary the Tern are close to those of the Weaver. Between Rugby and Market Harborough we cross from the Avon to the Welland at an altitude of less than 500 feet, and between Coventry and Nuneaton from the Avon to a tributary of the Trent at a little over 300 feet. At Moreton-in-the-Marsh we cross to the Evenlode and Thames at about 440 feet. It may thus be seen what an important series of routes across the land is provided by the Severn and its tributaries.

From plain to gorge.—We will for the present leave out of consideration the Welsh part of its course, and start with the Shropshire plain. Here **Shrewsbury** is found built within a horse-shoe loop of the river at a point where, as the contour-map shows, the low ground on either side is most contracted. First a fortress, then a county- and market-town, it is now a great railway-junction, where lines from London and Birmingham to Wales cross the line from Bristol to the north. A few miles lower down an isolated high mountain, the **Wrekin**, is seen on the left; and by the river are the ruins of a Roman town, Uriconium, with a modern village Wroxeter: the similarity of these three names points to a common origin.

The Severn gorge, which soon follows, is partly cut through the Coalbrookdale coalfield (Lesson XXI.), and Ironbridge is on the Severn. The opening of the gorge southwards was, in time of war, an important strategic point, and on a suitably precipitous cliff was built a castle to guard the gorge. About this grew up the town of **Bridgnorth**, now a carpet-weaving centre

(like Kidderminster in Worcestershire), and consisting of a high and a low town separated by the cliff which makes communication between them troublesome. The high town contains the market which grew up under the protection of the castle ; the low town contains the factories, which are in need of nearness to river and railway.

Second plain.—The river Stour is a left-bank tributary which drains down from the high ground of the Black Country, and affords an important route from that district to the Severn. **Stour-bridge** with its clay-products (Lesson XXI.) and **Kidderminster** lie on its course, and **Stourport** at its mouth. Hence onwards the Severn keeps on the New Red rocks, and as far as Gloucester the river is canalized, *i.e.* its flow is controlled by locks (p. 229). The iron of Staffordshire and salt of Worcestershire travel in barges downstream, while timber and corn go upstream. The more valuable products of Birmingham industry travel preferably by rail.

The red marls of Worcestershire contain beds of salt, which is mined on a large scale at Droitwich, a few miles off the river. Near the confluence of the Teme, which comes from the hilly agricultural district of South Shropshire, is the cathedral city **Worcester**, manufacturing porcelain and gloves.

The broad plain in which the Severn now joins its tributary, the Avon, is very fertile and especially noted for **fruit-growing**. It is bounded on the west by the **Malvern Hills** and May Hill, in which ancient rocks stand up above the red plain, much as in Charnwood Forest. On the other side is the fine escarpment of the Cotteswold Hills. The towns along the Avon are mostly agricultural market-towns: **Stratford-on-Avon**, on the southern borders of the forest of Arden, is famous as the birth-place of Shakespeare, and is much visited by tourists on that account. The Severn-Avon plain also attracts invalids who do not care for sea-breezes, and **Malvern** at the foot of the hills of that name, **Cheltenham** at the foot of the Cotteswolds, and **Leamington** near Warwick, are inland health-resorts. In all these cases, as also at Bath, **mineral springs** are found, which are believed to be beneficial to the health.

LESSON XXVI.

THE SEVERN ESTUARY.

1. Plot the rise and fall of the tide at the three ports given above on squared paper, making a tenth of an inch represent an hour in the horizontal direction and a foot in the vertical direction. The mean level of the sea may be taken as half the greatest height given in the case of each port; and low water on any day may be taken as being as much below this mean level as the previous high water was above it. Indicate the position of the three ports on a sketch-map.

Low water is approximately 6 h. 20 m. after high water at Pembroke; 7 h. 10 m. at Port Talbot; 6 h. 40 m. at Portishead. The heights given are all measured above low water at spring tides.

SPRING TIDES IN THE BRISTOL CHANNEL.

September 10-12, 1908. (Full Moon.)

September.	PEMBROKE.				PORT TALBOT.				PORTISHFAD.			
	Time.		Height.		Time.		Height.		Time.		Height.	
	h.	m.	ft.	in.	h.	m.	ft.	in.	h.	m.	ft.	in.
10 { A.M. - - -	5	44	23	6	5	33	30	2	6	44	43	10
{ P.M. - - -	6	7	23	11	5	58	30	11	7	7	44	10
11 { A.M. - - -	6	29	24	4	6	22	31	6	7	29	45	6
{ P.M. - - -	6	51	24	7	6	44	31	10	7	51	45	10
12 { A.M. - - -	7	13	24	8	7	5	31	11	8	12	45	9
{ P.M. - - -	7	34	24	5	7	26	31	8	8	33	45	5

NEAP TIDES IN THE BRISTOL CHANNEL.

September 18-20, 1908. (Last Quarter.)

18	{ A.M. - - -	11 31	16 3	11 24	20 6	—	—
	{ P.M. - - -	—	—	12 0	19 8	0 26	30 6
19	{ A.M. - - -	0 8	15 10	—	—	1 6	29 9
	{ P.M. - - -	0 51	15 8	0 40	19 4	1 51	29 7
20	{ A.M. - - -	1 39	15 9	1 23	19 8	2 38	29 11
	{ P.M. - - -	2 23	16 2	2 7	20 6	3 23	30 9

2. Make a percentage diagram (like Fig. 14) of the imports of Gloucester. Place by the side of it a diagram of the exports as a whole *on the same scale*.

GLOUCESTER—CHIEF IMPORTS AND EXPORTS, 1907.

IMPORTS.		EXPORTS.	
	£1,000		£1,000
Corn, chiefly Wheat - -	1,624	Coal, Coke, etc. - - -	5
Metals (Iron, Steel, and Zinc) - - - - - }	68	Raw Hides - - - - -	2
Cotton-seed and Linseed -	311	Machinery - - - - -	1
Sugar - - - - -	412	Manure - - - - -	1
Timber - - - - -	532	Iron, Iron and Steel } Manufactures - - - }	10
Other articles - - - -	109	Oil - - - - -	3
		Salt - - - - -	6
		Other articles - - - -	5

3. From what districts are the *coal*, *salt*, and *iron* and *machinery* exported at Gloucester probably brought respectively? What is the nearest inland area of large population to Gloucester? What are the manufactures produced in that area? Assuming that most of the imports of Gloucester go to that area, can you find a reason why so small a quantity of its manufactures are exported from Gloucester?

4. Measure the length of the Ship Canal from Sharpness to Gloucester (Fig. 48).

Gloucester, a bridge-town.—As the Severn and its tributaries form such an important series of routes into the heart of England; it might be expected that the point where sea and river-navigation meet, the lowest point where the river is easily bridged, should be a town of great importance, like London. The bridge-town of the Severn is Gloucester, and its name, like others ending in *cester*, *chester*, *caster* or *xeter*, shows it to have been a Roman fortified town. Gloucester, Worcester and Wroxeter were in fact the three Roman stations on the Severn. Yet Gloucester, though the nearest port to the great industrial district of the Black Country, is a town of less than 50,000 inhabitants: the explanation of its relatively small

importance is to be found in the special features of the Severn estuary.

The Severn bore.—This estuary broadens out funnel-like westwards to the Bristol Channel. The tidal wave entering this channel twice daily from the Atlantic is pent in between the narrowing shores and becomes higher and higher the farther it goes, until, as it nears Gloucester, its front takes the form of a wall of water rushing swiftly forward. At Chepstow, there is a difference of 60 feet between high and low water at



FIG. 49.—THE SEVERN BORE AT DENNY PILL.
From a photograph by Dr. Vaughan Cornish.
The bore is seen approaching in shallow water.

spring tides. This feature of the Severn estuary is a difficulty to navigation, and a great disadvantage to Gloucester. The disadvantage has been overcome partly by the construction of a **ship-canal**, which runs for 15 miles without a lock, and for the most part above the level of the alluvial land bordering the Severn which high tide would flood were it not embanked. The dock at **Sharpness**, the mouth of the canal, can only be entered at high tide, and specially constructed steamers carry the **grain**, and tow the **timber-rafts**, which are the main imports of Gloucester. Its exports are insignificant. The reason for this lies in the fact that it is the port of the Black Country. Its imports are cheap and bulky materials, to the ultimate price of which

cost of carriage makes a great difference: it is therefore essential that costly railway-carriage should be for as short a distance as possible. But the produce of much of the Black Country is mainly small and high-priced articles, on the price of which a far heavier railway-rate is a trifling addition, so that such of them as are for export can be as well dispatched from Liverpool, London or Southampton without the delay of a ship-canal journey. Only the cheapest manufactured articles are sent by Gloucester. Gloucester does not export its own



FIG. 50.—THE SEVERN BORE AT DENNY PILL.

From a photograph by Dr. Vaughan Cornish.

A side view in deep water, about a minute later than Fig. 49.

productions even: there are railway-carriage and wagon-works there, but when carriages are made for foreign railways they are sent to Newport for shipment.

Forest of Dean.—Near the end of the canal, at Sharpness, the Severn, nearly a mile wide is crossed by a high-level railway-bridge which affords a direct route for the carriage of coal from the Forest of Dean, on the west side, to the cloth-factories of Stroud on the east. The coalfield of the Forest of Dean differs in its geological structure from those so far described. The Midland Coal-measures protrude, as it were, through rents in the overlying New Red Sandstone; the North Staffordshire

and Derbyshire Coal-measures are separated by a protruding mass of Carboniferous Limestone, and dip down in opposite directions under the New Red Sandstone. The Dean Forest coalfield is *geologically* a **basin**, with Carboniferous Limestone for its rim and *Old Red Sandstone* around that ; but geographically it is a plateau, 600 feet above sea-level, cut nearly into two by deep stream-valleys running north and south. There are no manufactures and therefore no large towns on this coalfield. A small iron industry has existed since Roman times. The trees of the forest were, before the days of ironclads, considered the finest in England for naval purposes, and so they were preserved carefully, which fact must have checked the iron industry before coal was used for smelting.

Through the western limestone rim of the basin, the river **Wye** meanders in a series of beautiful gorges to its mouth at **Chepstow**, once, as its name implies, the *trading-place* between English and Welsh ; now a small port with engineering works.

Cloth-weaving.—On the other side of the Severn rises the high Oolite escarpment of the **Cotteswold Hills**, cut into by deep valleys, the streams of which flow steeply to the Severn. Chief of these is the **Stroud Valley**, along which the railway and canal run from Gloucester to pass by the **Sapperton tunnels** into the **Thames basin**. The Oolite downs, as has already been seen, are used for sheep-grazing, and the cloth-weaving industry, which once existed wherever sheep were plentiful, has persisted here, at **Stroud** and other places, where the rapid streams afford plentiful water-power. Of some importance in this connexion are the occurrence in the Oolites near **Bath** of **fuller's earth**—a soapy kind of clay used for removing grease from the wool—and the abundant growth, on the clayey soil of the **Lias**, of **teazles**, used for raising the nap on cloth. Another important **Cotteswold** industry is stone-quarrying.

Besides the bridge already mentioned, the Severn estuary is crossed by a railway-tunnel, over 5 miles in length, the longest in the kingdom, which carries traffic not only between London and South Wales, but also between Bristol and Liverpool and other towns in the north.

BRISTOL AND THE AVON.

1. Examine Fig. 51. Measure the area (a) of the whole map, (b) of the Bristol Avon basin, (c) of the united basins of the Yeo, Axe, Brue and Parret.



The shaded area is over 500 feet above sea-level.

2. Measure the distance (in miles) and direction of the following towns from Bristol (Bl.); stating the facts in tabular form :—Bath (B.), Swindon (Sw.), Salisbury (S.), Yeovil (Y.), Taunton (T.), Newport (N.).

3. Measure the approximate length of the Bristol Avon, dividing it into three parts, according to the general direction of its flow. State the length and direction of each of these parts. In which is its valley broadest? At what part of its course does this map show the valley to be narrowest? -

4. Examine Fig. 52, and the geological map. What is the geological structure of the Bristol coalfield? Make a sketch-

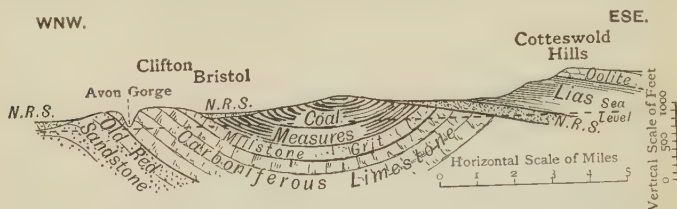


FIG. 52.—DIAGRAMMATIC SECTION ACROSS THE BRISTOL COALFIELD.

map to show what it would be like if there were no New Red Sandstone, Lias or Oolite in the district.

5. Examine Fig. 53. How many wide, and how many narrow, portions of the Avon valley are shown on it? Why



FIG. 53.—MAP OF BRISTOL AND THE LOWER AVON.
Contour-lines at intervals of 100 feet.

are there no indications of these narrow parts on Fig. 51? By comparison with Fig. 52, what rock-formations occur in each of these portions respectively?

6. By reference to the contour-lines, estimate the height of Clifton Bridge above the river. How high a dam would be necessary in the gorge at Clifton to make the Avon overflow into the valley of the Yeo? How much higher than the top of the dam would Clifton Bridge be? Make a sketch-map to show the area that would be flooded if such a dam were made.

The Bristol Avon, so called to distinguish it from other Avons, rises at the back of the Cotteswold escarpment, near the headwaters of the Thames, the watershed between the two



Photo.

G. W. Wilson.

FIG. 54.—THE AVON GORGE AND CLIFTON BRIDGE FROM THE SOUTH.

from Tetbury to Wootton Bassett (where the Great Western Railway crosses it) being low, as it there crosses the Oxford clay vale. Flowing southwards along this vale, it reaches a point near Trowbridge, where tributaries flow down to it from near the headwaters of the Wiltshire Avon and the Vale of Pewsey. Then the river turns west and afterwards north, running in a deep and narrow gorge across the Oolite ridge. Thence it emerges at Bath, to keep a meandering course over the low ground of Lias and Red Marl (interrupted by a less pronounced gorge where the underlying Coal-measures come to

the surface), until it meets the limestone rim of the coalfield. Through this it cuts a still narrower **gorge** at **Clifton**, finally emerging on to the alluvial flats bordering the Bristol Channel.

The site of Bristol.—Thus it will be seen that the Avon valley affords an easy route from the Bristol Channel across the Oolite ridge, either directly to the Thames valley and London, or indirectly thither by the Vale of Pewsey and Kennet Valley. Hence, trading vessels from Ireland long ago found that this was the best of the river-mouths along the Bristol Channel up which to sail. But they could not land their goods on the alluvial marshes, nor in the Clifton gorge, the sides of which rise in sheer cliffs over 200 feet high. So they landed them at the foot of the limestone ridge beyond the end of the gorge. Here a bridge was built, and here grew the city of **Bristol**, which for centuries was second only to London in trade and population. Its trade was first with **Ireland**, towards which the Bristol Channel opens; later, when **America** was discovered, with that country; and it is still with these that it does its greatest trade.

The manufacturing industries of Bristol are chiefly based on its American imports—**cocoa** and **tobacco**, but there is also much tanning and bootmaking. The limestone ridge carries the healthy suburb of Clifton, and the gorge is now spanned by a famous suspension-bridge. But the growth in size of modern ocean-going ships has placed Bristol at a disadvantage. The Avon is narrow, and subject to the great rise and fall of the Severn-estuary tides, which at low spring tides leave it more mud than water. To overcome these disadvantages, **docks** have been made on the channel shore—some at Portishead, under shelter of a limestone headland, west of the Avon, but the more important on the east side at **Avonmouth**. Here the largest ocean liners can discharge their cargoes, and great quantities of bananas, pine-apples, and other West Indian **fruit** are landed to be sent to the London market by fast train.

Bristol coalfield.—Bristol stands on the western edge of a coalfield a basin much larger than that of the Forest of Dean, and having its rim to a large extent buried under layers

of New Red Marl, Lias and Oolite. The southern rim, however, stands up prominently in the broad, flat-topped Carboniferous-limestone upland known as the Mendip Hills. This coalfield has no special industry settled on it, and supports no large town except Bristol, the importance of which dates far back to other causes than the nearness of coal.

Retracing the way up the Avon valley, Bath is reached, which has been famous since Roman times for its hot springs, and is chiefly a resort of invalids. Much oolitic limestone is quarried here, and fuller's earth is mined. At Bradford-on-Avon and Trowbridge on the Avon, and Frome on the tributary of that name, there is a cloth-industry, originally dependent on the abundant sheep of the oolite and chalk downs and the limestone downs of the Mendips, all near at hand; but now getting much of its wool from Australia, through London.

LESSON XXVIII.

THE MENDIPS AND SEDGEMOOR.

1. Examine Fig. 55. Measure the area of the map in square miles. Make a mask with an opening representing the same area on the scale of 25 miles to an inch and fit it over the corresponding part of Fig. 51. To what regions named on that map do the north-eastern and south-western portions of Fig. 55 belong? How do those two portions differ from the area between them in respect of the contour-lines?

2. Examine the south-western portion carefully. If the sea-level in the Bristol Channel rose 30 feet (as it does in places at high tides) and there were no embankments to keep the water out, what would be the condition of the Axe Valley? Make a sketch-map to show it. What explanation can you give of the numerous straight water-courses joining the Axe and its tributaries? What is the only sort of country in which such a system of water-courses is possible?

3. Examine the north-eastern portion of the map. Compare the isolated altitudes on the margin of this portion with the contour-lines and other altitudes farther north. What kind of

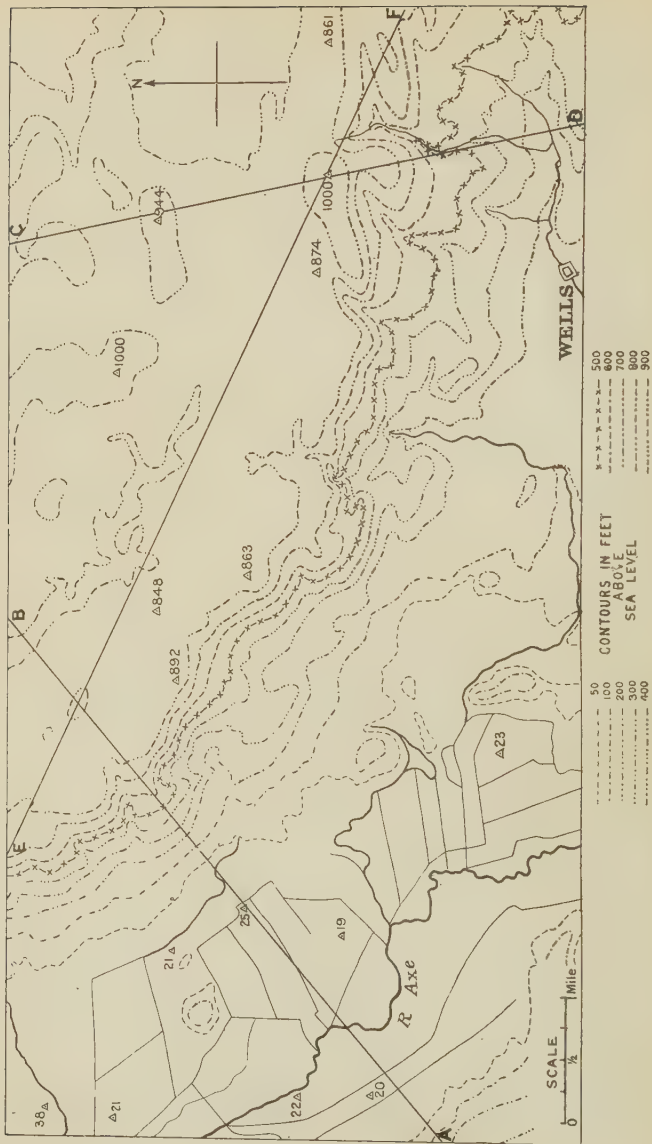


FIG. 55.—MAP OF PART OF THE MENDIP PLATEAU AND OF PART OF SEDGEMOOR.

ground do these altitudes indicate? How does it resemble and differ from (a) the ground of Sedgemoor (Axe Valley), (b) the intervening ground?

4. Draw sections (p. 40) along AB, CD, EF :

(a) On an exaggerated scale, the horizontal scale being the same as the map and the vertical scale an inch to 1000 feet.

(b) On a true scale, beneath the corresponding exaggerated sections, keeping the horizontal scale the same, but diminishing the vertical measurements to one-eighth.

The Mendip Hills might be named more accurately the **Mendip Plateau**, as they rise up very abruptly from little above sea-level to nearly 900 feet, and in a breadth of 5 miles rarely attain 1000 feet. Being principally composed of hard limestone, they support only short grass suitable for sheep-grazing. In places deposits of red and yellow iron oxides are dug, not for iron ore, but for paint (ochre). An interesting feature of this, as of other limestone areas, is the presence of **caverns**. The rain-water sinks along fissures in the limestone and gradually dissolves it away. Into these caverns some of the streams disappear, reappearing at a much lower level a mile or two farther from their source. The famous **Cheddar cliffs** are the sides of a gorge which appears to be a cavern of which the roof has fallen in. All these features—sheep, lead-mines and caverns—are repeated in the Peak District of Derbyshire and elsewhere, where there are large areas of Carboniferous limestone. The Cheddar gorge is, however, unique.

Sedgemoor.—At the foot of the steep southern slope of the Mendips lies the fen-district of Sedgemoor. This differs from the fens of the east in two respects—there is much more **peat** (that is, the compressed remains of masses of bog-moss, useful as fuel); and the islands are not all low and clayey, but are frequently high, steep-sided hills, as in the case of Glastonbury Tor. This region is famous in legend and history. Glastonbury Tor is the Island of Avalon, where King Arthur is said to have retired to die. Athelney (its name-ending recalling the place-names of the Fens) is associated with the warfare between Alfred and the Danes, and Wedmore with the peace with which

it ended ; while, 800 years later, the battle of Sedgemoor was the last fought on English soil.

Like the Fens, Sedgemoor has been drained, but it is more used for cattle-grazing than for crops ; it supplies Bristol with milk ; and Cheddar cheese is famous. The cathedral-town of **Wells** nestles at the foot of the Mendips. The other little towns are agricultural only. Along the coast, where limestone "islands" rise up from the alluvium, stand the sea-side resorts of **Clevedon** and **Weston-super-mare**. At the lowest bridge-place on the Parret stands **Bridgwater**, a port at which coal from South Wales and many other goods are landed for distribution to inland places in Somerset and Devon.

South Somerset.—East of Sedgemoor and the Mendip Plateau, the geological belts of rock which stretch across the country from Yorkshire can still be recognised. New Red Marl and Lias occupy so much of the low ground as is not covered by alluvium. The Oolite ridge is no longer a striking feature as in the Cotteswolds, but dies down into scattered heights. The Oxford clay vale is represented by the **Vale of Blackmoor**, east of which come hills of Greensand and the Chalk rim of the Hampshire Basin. But to the south a change takes place—the Greensand runs across the other belts to the west, until it comes in contact with the New Red Sandstone and almost touches the ancient rocks of Devonshire. Thus, the lowest point on the watershed between the Parret and Exe basins, tunnelled by the Great Western Railway, is on New Red Sandstone, with the ancient rocks of Exmoor rising up on one side and the Greensand of the **Blackdown Hills** on the other. This east-and-west range of Greensand hills forms the whole southern watershed of the Parret basin, and close to its lowest point, a pass communicating with the basin of the Dorset Axe, stands the town of **Chard**.

In view of the large extent of low ground north of this point it has been proposed to make a ship-canal from Bridgwater through Chard to Seaton, 30 miles or so in length. This would enable vessels from the South Wales coaling-ports to reach the English Channel without making the long and some-

times dangerous voyage of nearly 300 miles round the peninsula. The altitude of the pass at Chard (300 feet) is a serious difficulty to this project.

LESSON XXIX.

THE SOUTH-WESTERN PENINSULA.

1. Examine Figs. 56 and 57, and compare them with the geological map of the British Isles. Which is the largest area of high ground? Of what rock does it consist? How many other areas are there of the same rock? What heights do these severally attain? What large area of high ground is there not composed of this rock?

2. A line of watershed runs close to one coast for a considerable distance: state in words the course of this line. At what places is it interrupted? What rivers enter the sea at those places?

3. Which is the highest point in the south-western peninsula? On what area of high ground is it situated? Make a table of the rivers which radiate from this point, stating the directions in which they each flow from here to the sea, and measure their approximate lengths. In the case of streams which are tributaries, state where the main stream rises and its length above the confluence. Make a second table of all streams named on these two maps which are not included in the above table.

4. Represent the following facts by a percentage diagram.

OUTPUT OF TIN ORE IN THE BRITISH ISLES, 1906.

	Ore.	Amount of Tin obtained.
	Tons.	Tons.
Dolcoath Mine, Camborne - - - - -	1,814	4,086
Other Cornish Mines - - - - -	4,423	
Cornish Quarries, Foreshores, etc. - - - -	878	410
Devonshire Mines - - - - -	39	26
	7,154	4,522



FIG. 57.—THE SOUTH-WESTERN PENINSULA—EASTERN SECTION.
The shaded areas are bounded by the 500 and 1000-foot contour-lines.

CHINA CLAY AND POTTER'S CLAY RAISED IN ENGLAND, 1906.

	1000 Tons.	£1000.
Cornwall—China Clay - - - - -	584	375
Devon—China Clay - - - - -	71	55
Potter's Clay - - - - -	142	49
Dorset—Potter's Clay - - - - -	61	18

7. Make a sketch-map of the South coast of Cornwall, Devon and Dorset, marking the position of the clay-exporting

ports by spots or circles of four different sizes, according to the quantity exported.

SHIPMENTS OF CHINA CLAY AND POTTER'S CLAY BY SEA AND RAIL,
1906.

	1000 Tons.		1000 Tons.
Charlestown (Ch.) - - -	62	Penzance (P., fig. 47) -	4
Falmouth (F.) - - - -	3	Plymouth (P., fig. 48) -	30
Fowey (Fw.) - - - - -	472	Porthleven (Pl.) - - -	5
Newquay (N.) - - - - -	7	Wadebridge (W.) - - -	1
Par (Pr.) - - - - - -	78	Teignmouth (Tm.) - - -	27
Pentewan (Pe.) - - - -	14	Poole - - - - - - -	53

The figures for Teignmouth refer only to export to foreign countries; all others include coastwise trade also. About 11,000 tons are dispatched inland by rail.

Devon and Cornwall.—In the days when Sedgemoor was a sheet of water open widely to the Bristol Channel, the peninsula of Devon and Cornwall must have been connected to the rest of England by a narrow isthmus only 20 miles across. Even as it is, Bridgwater Bay is only 30 miles from Charmouth Bay. The peninsula thus marked off from the rest of England, corresponding approximately to the counties of Devon and Cornwall, differs in many respects from all other parts of England. The higher grounds, called **moors**, consist for the most part of **granite**—a rock which nowhere else in England occupies any large area.

There are five granite-areas—**Dartmoor**, **Bodmin moors**, the **St. Austell**, **Redruth** and **Land's End** areas. The altitude of these diminishes greatly from Dartmoor westward. The tendency of granite to weather into huge oblong blocks suggestive of masonry gives a characteristic appearance to the heights on these moors, which are called **Tors**¹ (Fig. 58). Great Links Tor (2039 feet) and Yes Tor (2028 feet) are the highest points on Dartmoor. The high area of Exmoor on the

¹ The name tor does not necessarily imply this appearance. Brent Tor and Glastonbury Tor are conical hills.

north is mainly composed of sandstone. The rest of the land is mainly of **slaty rocks**; but the New Red rocks form the eastern margin and send a narrow tongue in among the slates on the north of Dartmoor.

Drainage and coast-line.—The main watershed is peculiar in character: for most of its way it keeps near the north coast, often within 5 miles of it, so that the chief southern rivers rise



FIG. 58.—WEATHERING OF GRANITE, DARTMOOR.
From a photograph by Prof. S. H. Reynolds.

near the north coast; but the Torridge, which does the same, after flowing south for 15 miles, doubles back on itself and flows into the sea not far from where it rose. This and the Taw are the only long rivers flowing northward.

The form of the coast-line illustrates the destructive action of the sea and the effects of submergence. The Land's End granite has been made a peninsula by the more rapid destruction of the softer slates that surrounded it: it is on its way to become an island, and the **Scilly Isles**, also composed

of granite, are no doubt the last remains of a similar granite area, once part of the mainland. The shape of Morte Bay shows that its existence is due to two bands of harder rock with softer between. Submergence of steep-sided river-valleys along the south coast has led to the formation of the fine **harbours** of Falmouth, Fowey, Plymouth and Dartmouth. In places on the west coast extensive sand hills have been formed by the prevailing on-shore winds.

Tin-mining.—The great feature of the peninsula is its **mineral wealth**. The slates in the neighbourhood of the granite are traversed by numerous veins containing ores of tin, copper, lead, zinc, tungsten, etc. For many centuries Cornwall was the chief tin-producing country in the world, for tin-ores are not so widely-distributed in the world as those of most other metals. The exhaustion of the more accessible ore, as well as the discovery of tin-ores in Chile, Malacca and Tasmania, and of far richer copper-ores in North America, has caused a decay of the mining industry of Cornwall, but it still remains of some importance.

Besides metal-ores there is another very important mineral product, **china-clay**, a very pure white clay, formed by the decomposition of granite. This abounds in the St. Austell district and on parts of Dartmoor, and from the ports of **Fowey** and **Teignmouth** great quantities are exported to all parts of the world. Besides its great value in porcelain-making, it is also used in the manufacture of certain kinds of paper and in cotton-spinning; and the greatest export is to the Mersey, where it is in great demand for the Potteries on the one hand and the cotton factories of Lancashire on the other.

Where not decomposed, the granite is quarried. Splitting into large cubical masses, it forms a very durable stone for bridges and large buildings; some kinds when polished form very handsome ornamental stones. The Cornish slates are not so valuable as those of North Wales, but in places they are quarried on a large scale. Limestones are rare in the south-west, but thick masses occur at Plymouth and Torquay, and these when polished form very handsome stones and are

much used for ornamental work (chimney-pieces, table-tops and the like). As in other limestone areas, caverns with prehistoric remains are found near Torquay.

LESSON XXX.

THE SOUTH-WESTERN PENINSULA—(*Continued*).

1. Show, by a graph, the variation in the contents of the several columns of the table given below, found in passing through the three counties from west to east.

County.	Rain-fall.	% of Area Cult'd.	% Arable.	Of Arable.		Per 1000 Acres.		
				% Corn.	% Clover.	Pop.	Cattle.	Sheep.
Cornwall - -	45	70	58	33	53	371	257	451
Devon - - -	45	73	43	37	37	396	180	502
Somerset - -	35	82	21	43	23	419	241	458
England - -	—	76	44	46	23	876 ¹	156	458

2. Describe and illustrate by a sketch-map the course of the following railways :

L.S.W.R. (1) from near Chard (Ch.) through Axminster (A.) and Honiton (H.) to Exeter (E.), and thence through Crediton (Cr.), Okehampton (O.) and Tavistock (Tt.) to Devonport (D.) and Plymouth (P.).

(2) From Crediton to Barnstaple (B.), Bideford (Bf.) and Great Torrington (Gt.T.).

(3) From Okehampton to Launceston (L.), Camelford (Cm.), Wadebridge (W.) and Padstow (Ps.).

G.W.R. (1) From Taunton (T.) to Exeter, Dawlish (Dl.), Teignmouth (Tm.), Newton Abbott (N.A.), Totnes (Tn.), Ivybridge (Ib.) and Plymouth.

(2) Plymouth, through Devonport, Saltash (S.), Liskeard (Lk.), Lostwithiel (Lw.), Par (Pr.), St. Austell (St.A.), Truro (T.), Redruth (R.), Camborne (C.), and Hayle (H.) to Penzance (P.).

(3) Taunton, through Wiveliscombe (Wi.), and near Bampton (Bt.), to South Molton (S.M.) and Barnstaple.

¹ England and Wales.

3. Make a list of the harbours along the coast of the south-western peninsula from Bridgwater Bay round to the mouth of the Exe. Against each write (*a*) the names of the river-valleys which give inland communication from it, (*b*) the other basins, if any, with which they communicate by easy passes, below 500 feet.

Mark with a star those which appear to offer the best facilities for inland transport, and see whether these are more populous places than the less favourable ports in their neighbourhood.

4. Make a sketch-map of the south coast and place against the ports named below black, blue and red circles to represent the values of the three kinds of fish landed at each. Make the circles of four sizes—mere dots for values under 10, small circles for up to 20, larger for 20 to 100, still larger for over 100.

FISH LANDED ON SOUTH COAST OF ENGLAND, 1905.

	Fish caught in Nets— Mackerel, Herrings, Pilchards, Sprats.	Other Wet Fish caught mainly by Trawl.	Shellfish.	Total.
	£1000.	£1000.	£1000.	£1000.
Folkestone - - -	3	22	1	26
Hastings - - - -	7	12	0	19
Brighton - - - -	2	14	0	16
Warsash ¹ - - - -	0	0	11	11
Brixham (Bx.) - -	1	52	2	55
Plymouth (P.) - -	11	61	2	74
Mevagissey ² - - -	11	2	1	14
Falmouth (F.) - -	5	3	10	18
Porthleven (Pl.) - -	7	3	1	11
Newlyn ³ - - - -	188	44	0	232
St. Ives ⁴ - - - -	38	1	1	40
Total South Coast	306	246	64	616
East Coast - - -	1,145	4,713	201	6,059
West Coast (exclu- sive of St. Ives) }	63	719	35	827

¹ At the mouth of the Hamble, on the eastern side of the Southampton Water.

² South of Pentewan (Pe.).

³ In Mount's Bay, and just south of Penzance.

⁴ Strictly on the West Coast, but more conveniently counted with South Coast ports.

5. Represent by percentage diagrams—(a) the respective shares of the east, south and west coasts in total value of fish landed ; (b) the shares of Newlyn and St. Ives in the south coast mackerel, pilchard, etc., fishery ; (c) the shares of Brixham, Plymouth and Newlyn in the trawl-fishery.

Agriculture.—The granite and other moors of Devon and Cornwall are unsuitable for cultivation : even sheep do not find much subsistence there. The cultivated parts are in the valleys and along the coast of the extreme south-west. The mildness of the climate towards Land's End, due to the land being almost surrounded by the ocean, as well as being the first to receive the rain-bearing south-westerly winds, enables this corner of England to be used for raising produce such as can be had from no other part of the country. Early potatoes and broccoli and early spring flowers (narcissus and daffodils) are raised in large quantities near Penzance, and still more is this the case with the Scilly Isles, where frost is a rare event.

In the river-valleys, especially those of the Camel and Fowey (which together form a deep depression across the land from sea to sea), cattle are pastured. Cornwall stands fourth, and Devon takes a high place among cattle-raising counties. The relatively low area between the high grounds of Exmoor and Dartmoor, which includes parts of the valleys of the Torridge, Taw, Creedy and Culm, and the low parts of the intervening watersheds, is sometimes called the **Plain of Devon**, though far from being a true plain. But the richest region is on the eastern margin, where the New Red rocks form a rich soil. Here, on the borders of Devon and Somerset, fruit-trees, especially **apples**, are abundant, and cider is largely made. The most fertile part of this region is the **Vale of Taunton** or Tone valley, in Somerset. This vale opens out eastwards to the flats of Sedgemoor ; northwards it is shut in by the **Quantock Hills**, composed of ancient rocks like those of Exmoor, from which they are separated by a belt of New Red Sandstone. **Exmoor** itself lies to the east, and to the south are the Blackdown Hills, part of the main watershed between the Bristol and English Channels. Between Exmoor and the Blackdowns are two

comparatively easy passes to the valleys of the Exe and its tributary the Culm: these passes make the Vale of Taunton the easiest land-route into the peninsula.

Town-sites.—The majority of the small towns of the isthmus and peninsula are ordinary market-towns; but Honiton makes lace and Axminster carpets. Taunton, the county-town of Somerset, is not only the centre of its fertile vale, but commands routes into Devon, and so is an important railway-junction.

Exeter, county-town of Devon, is shown by its name to have been a Roman fortress, and is an ancient cathedral city; therefore it may be expected to occupy a commanding situation. The map shows it to be at the head of the estuary of the **Exe**, not far from the confluence of its tributaries Culm and Creedy. The Culm leads over the watershed to the Tone valley, and forms the most natural approach to Devon from Bristol and London, now occupied by the Great Western railway. The Exe itself, rising far north in Exmoor, forms a route to the north coast. The Creedy flows for part of its course on the westward tongue of New Red rocks which forms a belt of low ground crossing the valleys of the Taw and Torridge and so forming a natural route to the north-west (now taken by the South-Western line to Barnstaple), and also by more difficult ways round the west flank of Dartmoor to the Tavy and Tamar valleys.

Plymouth, Devonport and Stonehouse, **the Three Towns** practically one, lie on the magnificent harbour, Plymouth Sound and its branches. **Devonport** is a naval station like Portsmouth; **Plymouth** may be compared to Southampton, with which it competes for the landing of mails, etc., from South Africa. It has the advantage of shortening the sea-voyage and increasing the railway journey, which means a saving in time but an increase of expense: it is therefore better for mails, where expense is less important than rapidity, but not so advantageous for goods. Falmouth might seem even better for mails, but the railway through Cornwall is a meandering line with severe gradients, and an express train on it can scarcely save time on an ocean liner.

In Cornwall, **Bodmin**, the county town, is on a low pass between the Camel and Fowey valleys; Truro, Redruth and Camborne are mining towns; Hayle makes boilers and dynamite for use in the mines. The seaside towns are fishing-ports or ports for local trade, or holiday resorts.

Fisheries.—Projecting as the South-Western peninsula does into the ocean, away from other land, its harbours serve for the landing of fish caught over a wide area of sea; but in the absence of such a feeding ground as the Dogger Bank, none of the fishing ports attain the importance of Grimsby or Yarmouth. Mackerel and pilchards, caught by net, are landed mainly at Newlyn (near Penzance) and St. Ives; while Plymouth and Brixham are the chief ports for **trawlers**. These are boats which catch fish by trawls—nets supported on strong frames and dragged along the sea-bottom. Flat-fish (soles, plaice, etc.) are especially caught in this way.

Cornwall is called “the land of tre, pol and pen,” because so many of its place-names commence with one of those prefixes. *Tre* means a dwelling; *pol*, a creek, and *pen*, a head-land.

LESSON XXXI.

THE SOUTH WALES COALFIELD.

1. Compare Fig. 59, A and B. On what geological formations are the main courses of the Usk and Towy respectively? What is, in general terms, the relation of their southern watershed-line to the South Wales coalfield? How does the drainage of this coalfield differ from that of such geological basins as those of London and Hampshire? In what direction do the rivers generally flow in the eastern half of the coalfield? In the western half?

2. Compare Fig. 59, A and C. What physical characters of the coalfield can be inferred from the relation of the railways to the rivers? Coal mined in the Rhondda valley (R.) may be shipped at Cardiff (C.), at Barry (By.) or at Port Talbot (Ab.): by which route would it find the easiest gradient, and by which would it have to pass through the longest tunnel?

A.



B.



C.

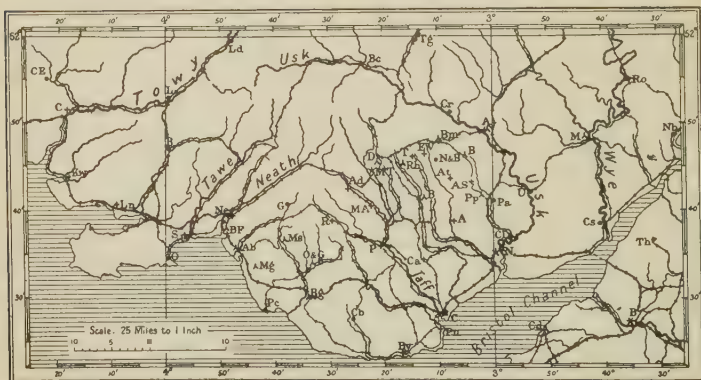


FIG. 59.—THE SOUTH WALES COALFIELD.

A, orographical (contour lines at 500 and 1000 feet); B, geological; C, railways

3. Estimate the greatest altitude attained by the railway between Abergavenny (A.) and Merthyr (M.T.). Can you explain why a railway has been made along this high watershed, while one has not been made along the Usk valley from Abergavenny to Brecon (Bc.)?

4. Make a geological sketch-map of the South Wales coalfield. Mark upon it by dots the number and position of the blast-furnaces in work during 1906 :

Briton Ferry (B.F.)	-	-	1	Swansea (S.)	1
Cardiff (C.)	-	-	2	Blaenavon (B.)	5
Merthyr and Dowlais (M.T., D.)			8		

Define the two districts in which these furnaces occur.

5. What percentage of the total coal (*a*) exported and (*b*) shipped coastwise, is sent from each of the ports of the South Wales coalfield? Express the facts by a diagram.

Which of the ports in the following table ship over 3 million tons of coal in all? What percentage of the coal shipped at these ports is exported? What percentage at all South Wales ports? At all other ports?

COAL, COKE AND PATENT FUEL EXPORTED AND SHIPPED COASTWISE FROM PRINCIPAL COAL-PORTS, 1906.

	Exported.	Coastwise.		Exported.	Coastwise.
	1000 Tons.	1000 Tons.		1000 Tons.	1000 Tons.
Cardiff ¹ - - -	16,523	2,747	Grimsby - -	1,475	151
Newcastle - -	6,358	2,665	Port Talbot -	1,143	198
Newport - - -	3,678	805	Leith - - -	1,121	185
Blyth - - -	3,664	589	Goole - - -	1,109	1,179
South Shields -	3,541	2,126	Grangemouth -	1,094	168
Swansea - - -	3,171	347	Liverpool - -	379	1,951
Sunderland - -	2,880	2,266	Other ports in		
Hull - - - -	2,527	851	S. Wales -	380	362
Methil (Fife) -	2,415	169	Other ports -	2,958	4,772
Burntisland - -	1,741	106			
Glasgow - - -	1,635	672	Total - -	57,792	22,309

6. Omitting Nos. 5, 6, 7 and 9 on the table given below, find the percentage of the total coal raised in each coalfield

¹ Including Penarth and Barry.

which is exported abroad. Assuming that coal exported is mainly for use in steamships, which coalfield would you infer as producing the best steam-coal?

EXPORT OF COAL, 1906.

Coalfield.	Total Raised 1906.	Total Exported 1906.
	1000 Tons.	1000 Tons.
1. Scotch - - - -	37,992	9,072
2. Durham, etc. - -	52,097	17,097
3. Yorkshire, etc. - -	59,530	5,197
4. Lancashire - - -	25,217	627
5. Midlands - - - -	21,136	} 206 ¹
6. Small Coalfields -	4,760	
7. North Wales - -	3,170	
8. South Wales - -	47,056	23,401
9. Irish - - - - -	94	1
Total - - - - -	251,051	55,601 ²

Steam-coal.—A hundred years ago, a traveller crossing the Bristol Channel from one of the North Devon or Cornish ports to one in South Wales would have noticed no great difference between the two. To-day, the difference between the small and quiet quays of Barnstaple and the busy crowded docks of Cardiff is very great, and is typical of the difference between the two mining areas on opposite sides of the channel. One is a metal-mining region, largely exhausted by many centuries of extraction and having to compete against the virgin mines of distant lands; the other is a coal-mining district, still with abundance stored in it, and the coal of which is eagerly sought for abroad as well as at home. For, though in the eastern part of the coalfield the coal is of the ordinary kind, westwards it becomes harder, giving when burnt less smoke and more heat, until in the extreme west **anthracite** is found which will scarcely burn in an open fire. The **steam-coal** of the

¹ Total Export from ports not close to any particular coalfield.

² This total differs from that in the previous table, as it does not include coke and patent fuel.

central parts is especially valuable for locomotives and steamships and great quantities are exported for their use. The coal-dust, cemented by tarry substances, is made into blocks (briquettes) of convenient size, and is known as **patent fuel**.

The South Wales Basin.—The coalfield is a geological basin, like the Forest of Dean, but much larger, being of about the same area as the Hampshire basin. Its drainage system is quite unlike that of the latter or the London basin. There is no central river, but from a watershed in the Old Red Sandstone to the north a number of streams flow right across the basin to the Bristol Channel. Those in the west, the Tawe¹ and Nedd (Neath) flow south-westwards, in the centre the Taff and its tributaries flow south-eastwards; in the east the Rhymney and Ebbw² flow almost due south, with eastward bends. Thus there is left a central mass of high ground from which shorter rivers—the Ogwr² or Ogmore being the chief one—flow to the south, and attached to this is a broad area of undulating agricultural land, the Vale of Glamorgan, between coalfield and sea. Farther west the sea breaks through the rim of the basin and beats on the Coal-measures. To the east the limestone rim is complete, and the Taff, Rhymney and Ebbw cut deep gorges through it, while there is a broad strip of Severn alluvium between it and the channel.

This system of drainage greatly facilitates the business of the district, which is, first and foremost, the mining and shipping of coal. The deep valleys enable the coal to be got at frequently by level “adits” as well as by the more expensive shafts. The railways nearly all run along the valleys, in some cases two competitive lines, one on each side of the stream; and the engines have their work made easier by the fact that the heavy loads of coal go downhill to the docks, while on the return uphill journey the trucks are empty or only loaded with pit-wood (timber for propping up the mine-galleries). The

¹ Pronounced in two syllables, *Ta-we*. To an English ear the name sounds almost the same as that of the *Towy*.

² The letter *W* in Welsh words (unless obviously a consonant as in English) is a vowel, pronounced like *oo*.

ports, chiefly engaged in coal-export, are at or near the river-mouths—Llanelly,¹ Swansea, Port Talbot, Cardiff and Newport. The only exception is Barry Dock on the coast of the Vale of Glamorgan, which is connected with the same valleys as Cardiff and is situated more conveniently for steamers, as there is deeper water close to that part of the coast.

Iron-ore occurs along the northern margin of the basin, and here great iron-works like those of the Black Country are found—at Ebbw Vale, Sirhowy, Tredegar, Rhymney, Dowlais and Merthyr. This industry affords an interesting illustration of industrial inertia, for now most of the ore is imported from Bilbao, on the north coast of Spain, and has to be hauled 20 miles or more inland by rail to the furnaces. To avoid this haulage, blast-furnaces were, some years ago, erected at Cardiff, where they can receive their ore direct from the ships; but the greater share of the industry is still taken by the inland places.

Tin-plate.—Another metal industry of the district illustrates the same principle. In the days when Cornwall was the great producer of copper and tin ore, these ores were taken across the channel to Swansea to be smelted, that being the nearest point with coal at hand. In spite of the decay of Cornish mining Swansea remains a great metallurgical town, smelting ores of tin, copper and nickel imported from abroad, and the centre of a district noted for the **tin-plate industry**, that is to say, the coating of iron-plates with tin to protect them from rusting. This tinned iron is used for purposes for which pure tin would be too flexible and brittle and too expensive, particularly for “tins” in which preserved food of all kinds is stored.

While most of the railway-lines follow the valleys, linking up here and there by tunnels or over low passes, three important linking-up lines must be noted specially. A branch of the London and North-Western runs high up almost on the north-eastern watershed, through the iron-smelting district. The Great Western has a line parallel to this, taken across the

¹ The sound of the Welsh *ll* is produced by aspirating at the same time as sounding an *l*. It is the equivalent of the Old English *hl*, now obsolete.

eastern valleys by a series of lofty viaducts from Pontypool to the Taff; while one of its main lines runs through Newport, Cardiff, Swansea and Llanelly, along the southern margin of the coalfield.

LESSON XXXII.

CENTRAL WALES.

1. Examine Fig. 6o. In what direction does the watershed run in the Epynt hills? Note the difference between the course of the 1000 feet contour-line on the opposite sides of this watershed. To what type of hill-range does the Epynt belong? In which direction and up to what area can you trace the continuation of this type from the Epynt? Classify the rivers Towy, Upper Wye, Yrfon, Ithon and upper tributaries of the Usk, according to their relation to the hill-structures.

What parallel ranges to the Epynt show the same structure? Classify the rivers Teifi, the part of the Wye near Hay (H.) and its Talgarth (Tg.) tributary, the several sections of the Monnow, the Dove and the Black mountain tributaries of the Usk.

In what direction do most railways run when crossing the watersheds in Central Wales? Give a reason for this.

2. Describe and illustrate by a sketch-map the course of the following railways:

G.W.R. (1) From Gloucester through Chepstow, and from Bristol through the Severn Tunnel to Bridgend (Bg.), Aberavon (Ab.), Briton Ferry (B.F.), Neath (Ne.), Swansea (S.), Llanelly (L.), Kidwelly (Kw.), and Carmarthen (C.) to Fishguard (F.), and to Haverfordwest (Hw.) and Neyland (Ne.).

(2) From Carmarthen to Lampeter (Lp.), Tregaron (Tr.) and Aberystwith (A.).

(3) Midland, from Hereford (Hf.) through Hay (H.), Talgarth (Tg.) and Brecon (Bc.) to Swansea.

(4) Cambrian, from Brecon, through Talgarth, Builth Wells (B.W.), Rhayader (Ry.), to Llanidloes (Ld.) and Newtown (N. & L.).

(5) L.N.W.R., from Craven Arms (C.A.) through Knighton (Kn.), Llandrindod Wells (L.W.), Llandovery (Ld.), and Llan-deilo (Ldl.) to Swansea.



FIG. 60.—RIVER-BASINS OF SOUTH AND CENTRAL WALES.
Contour-lines at 500 and 1000 feet above sea-level.

3. Represent the density of population (per 100 acres) in Brecknockshire and Glamorgan by means of dots in a square.

BRECKNOCKSHIRE AND GLAMORGAN COMPARED.

	Brecknock.	Glamorgan (including Cardiff and Swansea).	All England and Wales.
Area, in thousand acres - - -	469	519	—
Total population (thousands) - -	54	860	—
Occupied persons (thousands) - -	23	353	—
Percentage of occupied population engaged in			
Professions - - - - -	4	4	4
Domestic service - - - -	18	9	14
Commerce - - - - -	—	3	4
Transport - - - - -	4	11	9
Agriculture - - - - -	22	3	8
Mines and quarries - - - -	18	30	6
Metal industries of all kinds - -	4	11	10
Building and construction - -	8	6	7
Making clothing of all kinds -	4	6	8
Supply of food, drink, lodging, etc.	8	6	8
Other occupations - - - -	10	11	22

4. Represent graphically the proportions of the population engaged in different occupations in the three areas tabulated above, *but unite with "other occupations" those in which the figures in the three columns show only trifling differences.* Make a list of those occupations whose percentage is thus fairly constant.

5. Using Bartholomew's *Touring Atlas*, make a sketch-map of the south-western part of Wales, as far east as Carmarthen and as far north as Cardigan. Mark by red dots places with the Welsh prefixes *llan*, *tre*, *pen*, *aber*, *rhyd* and *caer* (or *car*); and with black dots places with the English prefix *St.*, or the suffixes *ton* or *ford*.

State the relation of the distribution of Welsh and English names to that of low and high ground.

6. Make a percentage diagram to show the shares of Milford and Fleetwood in the total value of the two chief classes of fish landed.

Identify the six ports in the table on the map of England.

VALUE OF FISH LANDED ON THE WEST COAST OF ENGLAND
AND WALES, 1905.

	Mackerel, herrings, etc.	Other wet fish.	Shell-fish.	Total.
	£1000	£1000	£1000	£1000
Cardiff - - -	0	51	1	52
Swansea - - -	0	83	0	83
Milford - - -	60	283	0	343
Liverpool - -	0	58	5	63
Fleetwood - -	1	182	6	189
Douglas - - -	1	9	0	10

The Welsh Uplands.—The busy, populous coalfield just described forms a striking contrast with nearly all the rest of Wales, which consists of barren moors intersected by broad, fertile agricultural valleys. As was seen in the first lesson, Wales forms one of the five large areas of continuous high ground in Great Britain, and like all the others is composed mainly of rocks which rise up from beneath the Coal Measures, and may be referred to by the general name of **Ancient Rocks**, though on the geological map they will be found divided into a number of systems. The only one of these that need be distinguished separately is the **Old Red Sandstone**, which forms the high Black Mountains and Breconshire Beacons, north of the great coalfield, but becoming more marly and with less sandstone eastwards, sinks down into the relatively low, undulating ground of the Welsh border (Monmouthshire, Herefordshire and South Shropshire).

Drainage.—Like the other upstanding areas, Wales is a rainy country, and from its high grounds many streams flow to the sea. Although the sea lies on three sides of it only, the drainage is in all four directions, and as the main watershed lies nearer the western side of the land (being scarcely above

10 miles from Cardigan Bay in one place), the rivers flowing towards England are the longest, and they have to add to their total length by at last turning north or south to reach the sea.

Although the arrangement of rivers and watersheds in this mountainous region is somewhat intricate, some simple features stand out clearly. Chief of these are a series of parallel **escarpments**. The most westward of these has the long Teifi valley at its foot. The second and longest begins in Radnor Forest and is continued by the Epynt Hills. The Wye cuts across this escarpment much as the Thames cuts across that of the Chalk. The vale at the foot of the escarpment is occupied by right- and left-bank tributaries of the Wye, the Yrfon and Ithon, and by the Towy; and the London and North-Western railway to Swansea follows this vale, escaping from it at a point where the watershed is cut by a deep wind-gap, in which little tributaries of the Towy and Loughor are separated by an imperceptible rise at about 200 feet above the sea. The little market-town of **Llandeilo** owes its importance to being the nearest point on the Towy to this low pass, while **Carmarthen** and **Llandovery** mark respectively the lowest bridge-point and the point where begins a rapid rise to the pass (at 900 feet) to the Wye valley. A third, much shorter escarpment is that of the Black Mountains, at the foot of which runs a short section of the Wye (at right angles to its general course), and a tributary which comes down from a rather low pass (about 600 feet) to the Usk valley. Near this pass, at the point where a number of streams from the dip-slope of the Epynt unite into the Usk, stands the county-town of **Brecon**.

Independence of Wales.—The geography of Wales to a large extent explains its history. Here have persisted to the present day the descendants of those races that inhabited most of Great Britain in Roman times, and elsewhere were either driven away, exterminated or absorbed by the invading English, or only persisted in small isolated areas. The only other large area in the south where they persisted was Cornwall; and in Wales alone has their language remained in use until now. A land of

high moors, intersected by valleys, is not one conquered easily, nor one where foreigners can very well settle down among a hostile population. Consequently, it is only in the low-lying parts of Wales, such as Pembrokeshire and Anglesey, that Englishmen have settled to any extent. Yet the moorlands had their disadvantages for the Welsh, as they prevented union between the tribes that occupied the several valleys. There is no natural centre to Wales, consequently Wales never was a kingdom, and the broad valleys opening towards England or to the north and south coasts afforded routes by which the country could be conquered piece-meal when the Normans had introduced the art of castle-building. The series of castles along the Welsh border and along the main valleys remains to mark the stages of the conquest. In all this Wales presents a great contrast to Scotland, as will be seen later.

The difference of language shows itself in the place-names. Many of these begin with Llan¹ or Aber;² some with Tre or Pen, as in Cornwall; others with Pont (bridge), Rhyd (ford), Cwm (valley) or Caer (corresponding to English caster or chester). In Herefordshire, how the English settled down among the Welsh is shown by the occurrence of Llanfaenor and Rockfield, Llanwarne and Harewood, as names of adjacent villages; and similar cases may be found in the Vale of Glamorgan and in Pembroke.

Railways.—The railways of Wales illustrate the features of its geography. The only three lines on which first-rate expresses run skirt its margins. The Chester and Holyhead line keeps close along the north coast except where it crosses the low plain of Anglesey. The South Wales line from Gloucester to Fishguard and Milford Haven keeps near the south coast, serving Newport, Cardiff and Swansea on the way. The third main line leaves this last near Newport (being connected to Bristol

¹ Literally an enclosure, meaning the enclosure round a church: the suffix is the name of the saint to whom the church is dedicated, so that in a free translation *llan* may be rendered "saint." Lampeter, for instance (properly Llanbedr) is St. Peter. Llanfihangel denotes a church dedicated to angels.

² *Aber* means the confluence or mouth of a river.

and Plymouth through the Severn Tunnel) and strikes northward by the lowland of Old Red Sandstone, through Abergavenny and Hereford, Leominster and Ludlow to Shrewsbury: beyond this its course is over the New Red plain to Crewe, etc.

The other railways penetrate into the heart of the country from England by the valleys of the Dee, Severn, and Wye; and are continued on to the coasts by the river valleys flowing thither. It is a striking illustration of the attraction exerted on railways by industrial centres, that there is no railway along the easy route of the Usk valley from Abergavenny to Brecon: to get by rail from one of these towns to the other it is necessary to climb high up on the watershed and down again, because there are ironworks along that route and only farms along the valley.

A curious illustration of the railway-geography of Wales is the fact that the favourite meeting-place for conferences of persons from all parts of Wales is Shrewsbury—a town outside Wales, but more easily reached from all parts of Wales than any town within its boundaries.

LESSON XXXIII.

NORTH WALES.

1. Examine Fig. 61. Measure the length of the Dee, Clwyd, Conwy and Dyfi rivers, and the area of the Dee basin. Measure the straight-line distance and the length of the straightest possible sea-route from Liverpool (Lv.) to Llandudno (L.), Holyhead (Hh.) and Aberdovey (Ad.).

2. What striking difference does the valley of the Clwyd show from the other river-valleys of Wales? Refer to the geological map: with what other area in Fig. 61 does the Vale of Clwyd agree geologically?

3. What striking difference is there between Anglesey and the mainland of North Wales? How do you account for the relative rainfall of Anglesey, Flintshire and the rest of North Wales (see Table, p. 169)?

4. Describe and illustrate by a sketch-map the courses of the following railways :-

(1) L.N.W.R. from Chester (Ch.), through Flint (Fl.), Rhyl (R.), Colwyn Bay (Co.), Conway (C.), Bangor (Bg.), and Menai Bridge (M.B.) to Holyhead (Hh.).



FIG. 61.—RIVER-BASINS OF NORTH WALES.
Contour-lines at 500 and 1000 feet above sea-level.

(2) Bangor through Carnarvon (Cn.) to a junction near Criccieth (Cc.).

(3) Llandudno junction (on the eastern side of the River Conway) through Bettws-y-coed (By.C.) to Festiniog (F.).

(4) G.W.R.—Ruabon (Rb.), through Llangollen (Ll.) and Corwen (Cw.) to Bala (Bl.), Dolgelly (Dg.) and Barmouth (Ba.), with a branch from Bala to Festiniog.

(5) Cambrian—from Whitchurch (Wh.) through Ellesmere

(E.), Oswestry (O.), Welshpool (W.), Montgomery (M.), Newtown (N. & L.) and Machynlleth (Ma.) to Aberystwith (A.).

(6) From Machynlleth to Aberdovey (Ad.), Barmouth, Portmadoc (Pc.), Criccieth and Pwllheli (P.).

5. Plot the statistics given below on squared paper, representing the counties by a vertical line an inch apart; and percentages by tenths of an inch measured from a horizontal base-line.

Divide the occupations given below into two classes, according as they show great or little variation from county to county.

SOME OCCUPATIONS OF THE INHABITANTS OF NORTH WALES.

Percentage of total population engaged in	Montgomery.	Anglesey.	Merioneth.	Denbigh.	Flint.	Carnarvon.
Professions - - - - -	3	3	4	4	4	4
Commerce - - - - -	1	1	1	2	2	2
Supply of food, drink, lodging, etc.	5	5	5	6	6	6
Agriculture - - - - -	39	32	24	19	16	15
Mines and quarries - - - - -	2	4	21	19	14	22
Making metals and machinery - -	2	3	2	3	7	2
Textile industry - - - - -	3	0	0	0	0	0
Rainfall - - - (inches)	60	36	65	45	30	65

6. Make a sketch-map of North Wales divided into counties. Write on each county-area the name of the most characteristic industries, viz. *Agriculture* in cases where that greatly exceeds all others; *Coal-mining* where the "mines and quarries" percentage is high if the geological map shows a coalfield, and *Slate-quarrying* if there is no coalfield; *Flannel-weaving* is the only case where "Textile Industry" has an integral percentage.

Glaciation.—The highest ground in all Wales occurs in the north-west, culminating in the peak of **Snowdon** (3560 feet). These mountains are much visited in the summer by those who enjoy climbing, and they are also of great interest from the marks which they bear of the action of glaciers during the

Great Ice Age. Many of the rocks are polished beautifully and scratched by the ice which once was pushed slowly over them and the stones which it held frozen in it (Fig. 62). In many places, as on the Pass of Llanberis, great masses of stone are found unlike the rocks of the neighbourhood, which could not have been brought there in any way but by a glacier: such stones are called **erratics**. Much of the **boulder-clay** and other **drift** that covers large parts of the English Plain consists of



FIG. 62.—ROCK-SURFACE POLISHED AND SCRATCHED BY ICE-ACTION, LLANBERIS PASS.
From a photograph by Mr. J. H. Pledge.

fragments of rocks from Wales, brought there by ice in the Great Ice Age.

Lakes are characteristic of all mountainous districts that have been glaciated. A great mound of erratics of all sizes sometimes dams up a valley: Bala Lake and many smaller lakes (llynys) in North Wales have been formed in this way. But the largest now are artificial lakes, formed by damming up tributaries of the Severn (L. Vyrnwy) and Wye (Elan and Claerwen), which serve as reservoirs for the water-supply of Liverpool and Birmingham. The rainfall of Wales is so great that it can spare the water that these great cities need and yet

not itself suffer from any lack of water. Water at a high-level can also be used as a source of electrical power for the extraction of aluminium from its ores: Llyn Eigiau (in the high ground west of the Conway valley) is now used for this purpose.

Coal and slate.—Besides the great coalfield in the south, Wales has a smaller one in the north-east, on the borders of the Cheshire Plain, under which the Coal-measures sink, so that they may perhaps be continuous with those of North Staffordshire. The chief towns on this coalfield are **Wrexham**, Ruabon and Mold. The Carboniferous Limestone rises up on the west and contains veins of lead and zinc ore as in Derbyshire and the Mendips, the presence of which gives rise to metallurgical and chemical works along the Dee estuary.

In the north-west occurs the finest slate in the kingdom, and large slate-quarries are worked at Bethesda (near Bangor), near Llanberis and at Festiniog: the slates are sent to all parts of the kingdom by rail or by ship from Portmadoc or Carnarvon and other small ports on the Menai straits. A little gold is mined near Dolgelly and some copper in Anglesey. There is much stone-quarrying for local use in all parts of Wales, but the only stones (other than slate) that are valuable enough to be exported are the scythe-stones of the North Wales coalfield, the chert of the same (see p. 116), and the igneous rock of Penmaenmawr quarried extensively for paving-setts and road-metal.

The highest mountain-areas are bleak and uninhabited, but where there is enough grass sheep are found, and in South Wales mountain-ponies. In sheltered places there are little woods, where clog-makers from Lancashire work in the summer. The Welsh counties are foremost in the number of sheep they contain; and Welsh mutton and Welsh flannel are famous. Flannel-making was once carried on in many small towns in the valleys, but is now concentrated at **Newtown** on the Severn. Most of the towns of Wales outside the coalfields are little market-towns: of these **Welshpool** is also a railway-centre of some importance. There are pleasure-towns on the north-coast (**Rhyl** and **Llandudno**), the west coast (**Aberystwith** and

Barmouth) and inland (**Llandrindod Wells**, **Llanwrtyd Wells**); and many smaller places find part of their occupation in looking after summer visitors.

Ports.—Besides the coal-ports, the chief other ports are those for Irish traffic. Of these the principal is **Holyhead**, situated on a small island off the coast of Anglesey, and only 62 miles from Dublin, the chief city and port of Ireland. In the south-west there is an important naval dock-yard at **Pembroke** on the magnificent harbour of **Milford Haven**, but being too far from any great centre of population, this harbour is not otherwise as much used as it might be. Much mackerel and other fish caught out beyond the west of Ireland is landed here for transport by fast train to London; as are also cattle and dairy produce from Cork, Waterford and other ports in the south of Ireland. For swift transit across channel, Milford is now displaced by **Fishguard** on the north coast of Pembrokeshire.

The island of Anglesey offers a striking contrast to the mainland close by, for it is low and flat, with only one hill reaching 500 feet above the sea, except on the extreme west, where Holyhead Mountain (on a separate island) exceeds 600. It is a great cattle-raising island, having more cattle in proportion to its area than any other county in England and Wales — more than twice the average of them all. The narrow Menai straits are crossed by two bridges, a suspension-bridge for road-traffic and a tubular railway-bridge.

LESSON XXXIV.

THE WELSH BORDER.

1. Examine Fig. 63. What two geological formations occupy the largest areas? With what river-basins does each approximately coincide? What difference is there between the general altitude and relief of the land in these two areas? What geological formation separates them near the centre of the map? To what altitudes does this rise?



A.

B.

FIG. 63.—THE WELSH BORDERS.

A, orographical map (contour-lines at 500 and 1000 feet above sea-level);

B, geological and railway map.

It forms a minor watershed : between what rivers? State, as nearly as you can, by reference to the contour-lines, the altitude at which the railway crosses this watershed at Church Stretton (C.S.).

2. How many main watersheds does the railway cross between Newport (N.) and Crewe (Cr.)? Make a tabular statement of these crossings (including that at Church Stretton) showing

(a) The main streams on either side.

(b) Their position in miles N. or S. of the nearest town marked on the railway.

(c) Their altitude, stated as above or below 500 feet, with an estimate as to whether much or little above or below, based on relative distance from the contour-line.

3. On an outline county map of England shade the counties which have more than 1 per cent. of their area devoted to orchards, distinguishing by depth of tint whether the percentage is below 2, between 2 and 4, or above 4.

FRUIT-GROWING AND HOP-GROWING.

	Acres per 1000 devoted to		
	Orchards of all kinds.	Apple Orchards.	Hop-fields.
Hereford - -	52.8	45.1	12
Worcester - -	48.2	26.5	7.7
Middlesex - -	34	6.6	0
Kent - - -	30.6	12.7	30
Gloucester - -	25.6	16.7	0.06
Somerset - -	24.6	24.4	0
Devon - - -	16.5	16.2	0
Monmouth - -	11.3	10.4	0
All England - -	7.5	5.2	—

4. Calculate for each of the above counties the percentage of the orchard area devoted to apples. On the outline map write the word *apples* on the counties in which this percentage is over 70.

Write the word *hops* on the counties in which the percentage of area devoted to hops is over $\frac{1}{2}$.

5. Using Bartholomew's *Touring Atlas*, make a sketch-map of the country between the Usk and the Wye. Mark with red dots places with Welsh names (as shown by the prefix *llan*, *pen*, *cwm* or *caer*), and with black dots those with English names (prefix *St.*, or suffix *ton*, *church*, *ford* or *wood*).

The Border Lowlands.—The geological map shows that North Wales is bounded on the east by the branch of the New Red plain which runs up to the Irish Sea: this is called the **Cheshire Plain**. The branch which runs south to the Bristol Channel is much narrower, but opposite this lies the great expansion of the Old Red Sandstone, which as already mentioned is in its eastern part relatively low lying, though not so flat as the plain of New Red Sandstone. These two red sandstone areas are partially separated by the Malvern Hills and other small hill-ranges. Farther north a projection of the ancient rocks of Wales juts out to the Wrekin, crossing the Severn at its Coalbrookdale gorge. This projection forms a belt of rather high ground in South Shropshire separating the Old Red Sandstone area of Monmouthshire and Herefordshire from the Cheshire plain (which includes North Shropshire).

The lower-lying Old Red Sandstone area is an agricultural district, the soil being especially suitable for apples. Orchards are plentiful, and much cider is brewed. Herefordshire stands first of all the counties of England and Wales in the proportion of its area given up to orchards. Hops are also grown in quantities in parts of Herefordshire: in hop-production it is the second English county, though a very long way behind Kent.

Rivers.—The river **Teme**, rising in the Welsh hills that border the Severn valley on the south near Newtown, and the **Lugg** from Radnor Forest farther south, emerge near together at Ludlow and Leominster respectively on the Old Red lowland. This is a region of many **castles** (Stokesay, Hopton, Wigmore, Ludlow and others) which played an important part in the conquest of Wales. The Teme then flows east to join the Severn at Worcester, while the Lugg turns south to the Wye. From the high ground of South Shropshire the Teme receives

several parallel tributaries flowing at the foot of a series of limestone escarpments, known as **edges**. Wenlock Edge is the most striking of these.

The **Wye**, of which the first 35 miles or so are taken in a straight south-easterly course, then bends to the north-east at a point where there is a low pass to Brecon in the Usk valley at the foot of the Old Red escarpment. Ten miles farther on, it makes a second bend and emerges into the lowland. **Hereford** (the army-ford) stands where the Roman road from Wroxeter to Caerleon (near Newport) forded the Wye. The route of this ancient road is followed very nearly by the railway described below. Once in the lowland the Wye begins to meander in large loops, which lie in a wide valley to a little south of Ross when it meets with the limestone rim of the Forest of Dean basin. The limestone being a rock of very different character from the red marls of the lowland produces narrow and steep-sided gorges, and as the river still forms large loops this part of its valley is very picturesque. The beautiful ruins of Tintern Abbey form a further attraction to this part of the Wye valley, which keeps the same characters to its mouth at **Chepstow**. Here it is within the range of the high tidal wave of the Bristol Channel, and we can understand Tennyson's description :

“ There twice a day the Severn fills,
The salt sea water passes by,
And hushes half the babbling Wye,
And makes a silence in the hills.”

Railways.—Chepstow is near the **Severn Tunnel**, the longest tunnel in the British Isles—5 miles—which provides not only the most direct route from London, Southampton and Bristol to South Wales ; but also the most direct from Plymouth and Bristol to the north-west of England, by means of a railway along the Old Red lowland of the Welsh border. Leaving the South Wales railway near Newport, this line skirts the edge of the great coalfield by the Monmouthshire Avon and Usk valleys to Abergavenny ; then by tributaries of the Monnow (itself a tributary of the Wye) to Hereford ; up the Lugg valley and over the low watershed to the Teme ; up the Teme and its

tributary Onny. Here the upland of ancient rocks interposes, and the watershed is crossed at a height of 600 feet at **Church Stretton** (the name of which indicates that the above-mentioned Roman road or *street* ran this way), and so down to Shrewsbury and the open Cheshire plain where the railway lines are free to branch out to Chester, Manchester and elsewhere.

LESSON XXXV.

THE CHESHIRE PLAIN.

1. On Fig. 64 measure the area of the Mersey basin.

2. Make a sketch-map of this basin, distinguishing its watershed by a thin line where it is low and easily crossed by railways, and by a thick line where it is high and requires tunnelling. Mark the position of coalfields, potteries, salt-mines, mosses and rivers.

Sketch on this map the following railways, bearing in mind that there is little to prevent their running in very straight lines in the Cheshire plain. Write brief descriptions of their courses.

L.N.W.R. (1) Stafford (St.) to Crewe (Cr.), Warrington (W.), Wigan (W.) and Preston (P.).

(2) Stafford to Newport (Ne.), Wellington (Wl.), Shrewsbury (Sh.) and Welshpool (We.).

(3) Crewe to Chester (C.), Flint (Fl.), Holywell (H.), etc.

(4) Crewe to Runcorn (Ru.) and Liverpool (L.).

(5) Crewe to Stockport (Sk.) and Manchester (M.).

(6) Liverpool to Newton (N. in M.), Eccles (Ec.) and Manchester (the original Liverpool and Manchester Railway, 1830).

G.W.R. (7) Shrewsbury to near Oswestry (O.), Ruabon (Rb.), Wrexham (Wr.), Chester (C.) and Birkenhead (Bi.).

Cheshire lines (G.C.R., G.N.R. & M.R.).

(8) Manchester to Warrington (W.), Garston (Gt.) and Liverpool.

(9) Liverpool by Mersey Tunnel to Birkenhead, Neston (Nt.), Dee Bridge, Wrexham and Ellesmere (Em.).

3. Examine Fig 65. What is the horizontal scale? What is the vertical scale? Compare it with Fig. 64, and find on that the line of section. From the position of the salt-mines, Fig. 64, which geological formation do you conclude contains the salt? What is the thickness of this in the centre of its



FIG. 64.—THE CHESHIRE PLAIN.

Contour-lines at 500 and 1000 feet above sea-level.

extent? At what depth would coal probably be found under the salt district?

4. Make percentage diagrams to show (a) the relative quantities of salt raised in different districts, (b) the relative quantities exported from different ports, (c) the proportion borne by the exports from Lancashire ports, Gloucester and Middlesbrough respectively to the total salt raised in the adjacent districts.

PRODUCTION AND EXPORT OF SALT, 1906.

County.	Production.	Value.	Port.	Export.	Value.
	1000 tons	£1000		1000 tons	£1000
Cheshire and Staf-	1275 } 283 } 173 }	424 }	Liverpool - -	452	344
fordshire - -			Fleetwood - -	69	19
Lancashire - -			Gloucester - -	12	10
Worcestershire -	159	67	—	—	—
Durham - -	28	12	Middlesbrough -	53	36
Yorkshire - -	43	13	—	—	—
Antrim - -	4	3	—	—	—
Isle of Man - -					

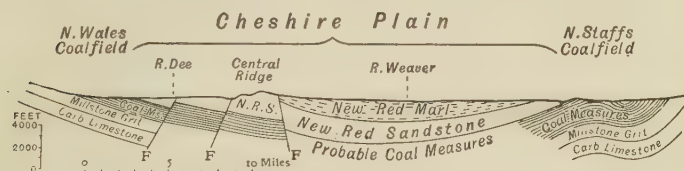


FIG. 65.—GEOLOGICAL SECTION ACROSS THE CHESHIRE PLAIN.

F, F, faults or dislocations.

5. How many towns of over 500,000 inhabitants are there on Fig. 64? How many of between 250,000 and 500,000? between 100,000 and 250,000? Tabulate them.

6. Make parallel percentage columns to illustrate the following table :

PERCENTAGE OF ARABLE LAND DEVOTED TO

	Wheat.	Barley.	Oats.	Potatoes.	Turnips, etc.	Clover.
Cheshire - -	7	$\frac{1}{2}$	31	12	7	38
Lancashire -	8	2	30	18	4	31
All England -	15	13	18	4	14	23

7. Calculate, and represent by diagrams, the percentage of the population engaged in the alkali, etc., industry in each of the following districts; and the percentages of the total occupied in this industry living in each of the four counties.

SALT AND ALKALI INDUSTRIES, 1901.

	Total occupied population.	Population engaged in Salt, Alkali and Chemical Works.
	1000	1000
Cheshire - - - -	375	5
Durham - - - -	457	2.5
Lancashire - - -	2090	8
Yorkshire - - - -	1612	3
All England and Wales -	14,349	30

The Cheshire Plain.—Between the mountains of North Wales and the Peak mountains of Derbyshire there lies a plain, 30 to 40 miles in breadth. Where this plain meets the mountains on either side, there is a coalfield—that of Flint in the one case, that of the Potteries in the other. The plain itself has for its subsoil one of the three great arms of New Red Sandstone that branch out from the centre of England. These New Red rocks are, however, hidden from view in many places by glacial deposits. As in Worcestershire, the New Red Marl contains beds of **rock-salt**, which has been mined extensively about **Nantwich**, **Middlewich** and **Northwich** for many centuries. (Compare the ends of these place-names with that of Droitwich, p. 131.)

Southwards, the plain extends to the Severn Valley in Shropshire. Northwards it continues through East Lancashire to Morecambe Bay, and here it includes a portion of the great Lancashire coalfield, between the east-flowing rivers **Ribble** and **Mersey**. The Cheshire portion of the plain is divided by a line of moderately high ground, the escarpment of harder beds of sandstone, into an east and west division occupied by the **Dee** and the **Weaver** respectively. The former, emerging from the beautiful Vale of Llangollen on the west, turns north, and then, in its estuary, north-east. The latter, rising within the limits of the plain itself, near tributaries of the Trent and Severn, flows north to Northwich and then east to the Mersey estuary. Between these two estuaries lies a peninsular branch of the plain, known as **Wirral**.

Importance in communications.—This Cheshire Plain is of great importance in the geography and history of England. Separating the two great upland masses—Wales and the Pennines—it forms the natural route from London and the south to the Irish Sea, and one of two alternative routes to Ireland (the other being by the Bristol Channel). The Romans founded **Chester** (Deva) as a fortress to guard all the south of England from invaders from the Irish Sea. Chester has lost its importance as a port, owing to the silting-up of the Dee estuary: Liverpool on the adjoining estuary has superseded it. But the importance of its site is still shown by its being an important railway junction—six main lines radiating from it, as well as minor branches.

An equally important junction in the Cheshire plain is **Crewe**, where the main line from London to Scotland meets branches from Bristol, Chester, Manchester and the Potteries. Here are the great locomotive-building and other engineering works of the London and North-Western Railway.

Cultivation.—The Cheshire plain is a rich agricultural and grazing district. Cheshire stands second to Anglesey as a cattle-raising county, and Cheshire cheese is famous. The presence of a large population near at hand (in the great towns of Lancashire) causes much of its soil to be devoted to the raising of produce that does not stand transit to a great distance—such as hothouse fruit, fresh vegetables and strawberries—in short, to what is called “market-gardening.”

Industry.—The description just given applies to North Shropshire and the greater part of Cheshire, but upon going north towards the Mersey and South Lancashire, great changes are found. The Mersey and its artificial twin, the Manchester Ship Canal, connect one of the greatest industrial regions in the world—the **cotton** district of Lancashire—with one of the greatest ports—the **Mersey estuary**; and all along their course large-scale industries tend to be established. Greatest of these is the **chemical industry** of **Runcorn**, **Widnes** and **St. Helens**. Here the **salt** of the Cheshire plain is converted into soda and hydrochloric acid; dyes for the printing of cotton are manufactured,

together with innumerable other products. Here too are great glass-works. The air of these towns is unpleasantly acid; metal objects quickly corrode and trees will not grow near them. The hides of the cattle from the plain or imported into the Mersey from abroad supply **Warrington** with the material for its large tanneries. At Runcorn, the central sandstone ridge of the plain reaches the Mersey, and there is much stone quarried.

Water supply.—Just as London obtains water by boring through the London Clay into the water-bearing Chalk below, so the towns on the Cheshire Plain pump up water from the beds of New Red Sandstone underlying the New Red Marl, which forms the subsoil of large areas. This marly subsoil holds up the surface-water, and in parts of the Cheshire Plain there are small shallow lakes known as **meres**, and in the Mersey valley there are old lakes filled up by the growth of vegetation forming **mosses** or **bogs**, with a solid surface, but so full of water that they will not bear any serious weight. Most of these mosses have now been reclaimed by drainage. The largest of them is Carrington Moss on the Cheshire side of the Mersey; there are others on the Lancashire side, including the famous Chat Moss, over which George Stephenson carried the Liverpool and Manchester railway. **Peat**, like that of Sedgemoor, is dug from these mosses (Fig. 68). The peaty soil, like that of the Fen district, is very suitable for the growth of potatoes, which are grown in Cheshire and Lancashire to a greater extent than anywhere else in England.

LESSON XXXVI.

THE COTTON TOWNS.

1. Compare maps A and B of Fig. 66. What geological formation forms the high ground of the main watershed? What forms the heights north-west of the Ribble? The ridge to the south-east of the Ribble? The watershed between Ribble and Mersey? What formation occupies most of the low ground near the west coast? What comes on the slope

A.



B.



C.

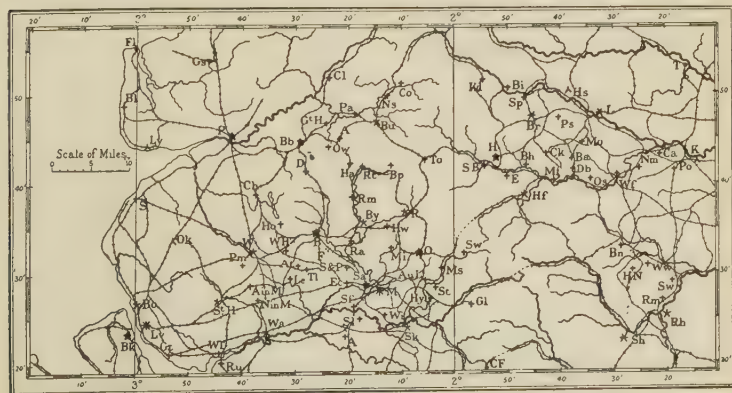


FIG. 66.—SOUTH LANCASHIRE AND THE ADJOINING PART OF YORKSHIRE.

A, orographical (contour-lines at 500 and 1000 feet above sea-level); B, geological; C, railways.

between low and high ground on each side of the main watershed?

2. Compare maps B and C of Fig. 66. On what formation do the two closest networks of railway lie? What feature did the railways show in the South Wales coalfield? What resemblances and differences can you see between the railways of the South Lancashire and Yorkshire coalfields and those of South Wales?

3. Divide the occupations tabulated in the first of the following tables into those in which Lancashire shows a larger, and those in which it shows a smaller proportion of the whole than does England and Wales.

This may be quickly done by noticing that the total occupied population of Lancashire is approximately one-seventh of that of the whole country; and then seeing which lines give Lancashire more than one-seventh.

Make a percentage diagram to show the proportions of the former occupations only, uniting the rest with "other work."

LANCASHIRE, 1901 (INCLUSIVE OF ALL TOWNS).

Numbers of population engaged in	Lancashire.	All England and Wales.
	1000	1000
Textile industries - - - - -	524	1155
Transport (railways, canals, road-vehicles, etc.) -	198	1268
Metals and machinery making - - - - -	181	1237
Domestic service - - - - -	175	1995
Supply of food, tobacco, drink and lodging - -	151	1074
Making dress of all kinds - - - - -	132	1126
Building and construction - - - - -	128	1044
Mines and quarries - - - - -	104	805
Commerce - - - - -	90	591
Professions - - - - -	65	607
All other work - - - - -	342	3447
Total occupied population - - - - -	2090	14,349

LANCASHIRE, 1901.—DETAILS OF TEXTILE INDUSTRIES.

Numbers engaged in	In thousands.		
	Males.	Females.	Total.
COTTON—Processes preparatory to spinning	11	39	50
Spinning - - - - -	49	24	73
Processes preparatory to weaving - -	15	52	67
Weaving - - - - -	58	152	210
Miscellaneous - - - - -	29	8	37
WOOL—All processes - - - - -	5	5	10
HEMP, JUTE, etc. - - - - -	2	3	5
SILK - - - - -	1	2	3
Other or mixed materials - - - - -	3	9	12
Bleaching, printing and dyeing - - -	27	5	32
	200	299	499 ¹

4. Make percentage diagrams to show

(a) the Lancashire share in the total of textile workers ;
 (b) the share of the four named textile materials and "other materials" in the total textile-workers of Lancashire.

(c) the ratio of males and females in the Lancashire textile industry generally.

5. Assuming that the proportion of all those engaged in bleaching, printing and dyeing, who are engaged upon *cotton*, is the same as for all the other processes, make a percentage table to show the relative numbers employed in all the processes in the cotton industry.

6. Represent these last statistics in another way, to show the relative employment of men and women in different processes. Draw a vertical line about an inch high, and at equal intervals draw horizontal lines from this to represent the various processes, beginning at the bottom with "processes preparatory to spinning." Make the lines drawn to the left proportional to the number of males employed, and those to the right proportional to the number of females. Write the name of each process opposite its line, and write "Males" and "Females" at the top, on the appropriate sides.

¹ The grand total of the detailed table falls short of the number given against "textile industries" in the previous table because the latter includes dealers in textiles.

South Lancashire.—The Lancashire coalfield neither is a basin like that of South Wales, nor does it rise like an island in the New Red Sandstone like those of the Midlands, but is something between the two. The Carboniferous Limestone and beds of grit and shale rise up from under the Coal-measures on the north and east, forming the Pennine moors, which lie mainly within the county of York; while the Coal-measures disappear below the New Red Sandstone on the east and south. There is also a considerable area of grit and shale thrust up in the centre of the coalfield, forming the **South Lancashire moors**. The surface of these moors is wild and open, covered with thin grass and occasional bog; while at intervals it is cut by narrow little glens with steep rocky sides and swiftly-flowing torrents fed by the abundant rainfall. A traveller on the moors will notice stone walls marking the boundaries of property, but houses are rare. Yet if he glances across the moor towards one of the wider valleys he sees the smoke of a great industrial town. As he follows the little glen down to the narrow valley into which it opens, he finds a continuous row of small houses along its one street, a railway winding along beside the stream, and at intervals a large factory. This is one of the cotton-spinning villages.

Cotton.—Why is **cotton-spinning** localized in South Lancashire? Because a damp atmosphere is necessary for the successful carrying on of the process. Why is South Lancashire rainy? Because it lies on the windward edge of the Pennine uplands. Why is not cotton spun in other rainy districts in England? Because cotton is not grown in England: the raw material must be imported—mainly from the United States—and no other rainy district has the port of Liverpool, with its facilities for American trade, so close at hand.

Spinning is not the only process to which cotton is subjected here. There is the **weaving** of the thread into a fabric, and the **dyeing** and **printing** of the fabric. All these processes are carried on in factories and require machinery, so that **machine-making** is a very important subsidiary local industry. The coal-mines of the district are occupied fully in supplying coal for

the factories and little is exported. The chemical works of the Cheshire plain supply the materials for dyeing.

Large Towns.—As the valleys begin to open out and unite, we pass from industrial villages to large towns—on the north side **Burnley**, **Accrington** and **Blackburn**; on the south **Bolton**, **Bury**, **Rochdale** and **Oldham**. So numerous are large towns here, that many which from their population would rank as important places in other parts of England must be passed over. Largest of all, where the Irwell, to which the other streams are tributary, enters the plain, stands **Manchester**, with a population (including its inseparable companion, **Salford**) of 900,000. Manchester is less a manufacturing city than a city of warehouses, the storehouse for the towns around; but it is also a great engineering centre, and, since the opening of the Ship Canal, has become a great sea-port. **Ashton** and **Stockport** stand at the foot of the moors east of Manchester. **Wigan** is a coal-mining and iron-smelting town and important railway junction on the edge of the moors.

Macclesfield, halfway between Manchester and the Potteries, may be mentioned here, though it stands apart from the cotton area, and is a **silk-weaving** town. Rochdale is not only a cotton town but has a considerable woollen (flannel) industry also.

As in South Wales, the railways follow the valleys, but are more often pushed through tunnels under the watersheds, and in the lower ground they branch out into an intricate network. The traffic they carry is of a very different kind from that of South Wales. Instead of a steady stream in one direction there is a most complicated interchange, for the various towns specialize very greatly both in the processes and in the quality of their products. Thus, the same cotton may be spun at Oldham, woven at Blackburn, bleached at Bolton, and warehoused at Manchester.

LESSON XXXVII.

LIVERPOOL AND THE LANCASHIRE COAST.

1. Examine Fig. 67. What is the scale? What is the length and breadth in miles of the area represented? What length and breadth will represent the same area on a scale of 25 miles to the inch? Make a mask of these dimensions and fit it on to Fig. 64 until it just exposes the area of Fig. 67. What is the compass-bearing of the sides of Fig. 67?

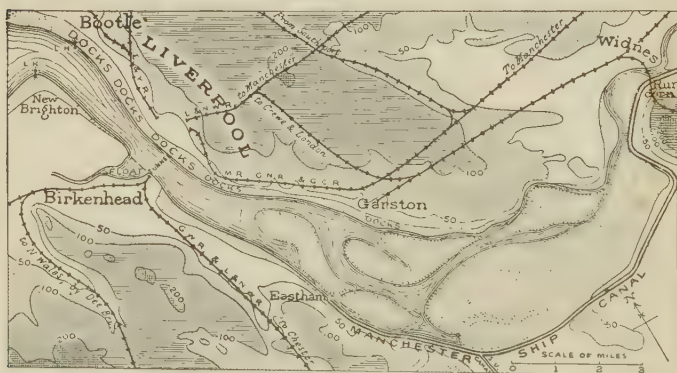


FIG. 67.—THE MERSEY ESTUARY.

The dotted areas lie between high- and low-water level.

Contour-lines at 50, 100 and 200 feet.

2. Measure the width of the Mersey estuary (including land liable to be covered at high tide):

- (a) At Bootle light-house.
- (b) Between Liverpool and Birkenhead.
- (c) At Garston.
- (d) Where it is widest.
- (e) At Runcorn railway-bridge.

3. What feature does the Mersey show between Runcorn and Liverpool docks that it does not show above or below that portion of its course? What advantages does the Liverpool shore offer for the construction of docks? What advantage does Garston offer to smaller vessels? Why could not the

Garston docks have been constructed higher up the Mersey? Why was Runcorn chosen as the site of a railway *bridge*, and Liverpool-Birkenhead as the site of a railway *tunnel*?

4. Measure the length of the Ship Canal from the locks at Eastham to Runcorn. Measure it from Runcorn to Manchester (on Fig. 64). Why does the portion from Eastham to Runcorn keep so close to the flood-plain of the Mersey? Why was the construction of this part necessary?

5. Where is the shore of the Mersey steepest on the north side? On the south side? Where does ground over 200 feet high come nearest to it? Why does the railway from Birkenhead to the Dee Bridge make such a bend at its start?

6. Extract from the table given below those imports and exports which either (*a*) amount to over 5 % of the total imports and exports of Liverpool, or (*b*) amount to over 25 % of the total for the United Kingdom. Make percentage diagrams for the import and export trade of Liverpool, uniting all other items with "other goods."

LIVERPOOL—CHIEF IMPORTS AND EXPORTS, 1907.

IMPORTS.	£ 1,000,000.	Total for U.K.	EXPORTS.	£ 1,000,000.	Total for U.K.
Cattle - - -	4	8	Apparel - - -	1	7
Rubber - - -	9	11	Railway carriages - -	3	4
Wheat - - -	9	37	Chemicals - - -	5	17
Other corn, flour, etc.	7	38	China and earthenware -	2	4
Raw cotton - -	53	71	Cotton goods - - -	63	110
Bacon - - -	6	15	Hardware, implements, and tools - - -	2	6
Beef - - -	5	11	Linen goods - - -	4	7
Other meat - -	5	14	Machinery - - -	11	32
Copper and copper ore	5	12	Iron, and iron and steel manu- factures - - -	16	47
Other ores - -	4	17	Other metals - - -	3	12
Sugar - - -	3	20	Soap - - -	1	1
Tobacco - - -	3	4	Wool and woollen goods -	10	37
Timber - - -	4	27	Other goods - - -	22	234
Wool - - -	6	36			
Other goods - -	37	325			
Total - - -	160	646	Total - - -	143	518

The Mersey as a port.—The estuaries of the Dee and Mersey must always have disputed with the Bristol Channel the chief trade between England and Ireland. Bristol had the advantage of being nearer to London, and was for a long time the second city in the kingdom, while Chester remained small and Liverpool was a mere village. But Liverpool has not the high tides of the Bristol Channel, the route from London is an easy one, thanks to the Great Red Plain, and Liverpool is opposite Dublin, from which all Ireland is more accessible than from any place farther south. In the rivalry between the Dee and the Mersey, the silting-up of the former estuary effectually stopped the trade of Chester; while the rush of the current through the bottle-neck kept the Mersey estuary deep. The rivalry of Holyhead began only when it was made accessible by railway.

The history of **Liverpool** was at first very like that of Bristol. Slaves, first from Ireland and then from Africa, were once a great part of its trade. Later came **tobacco** and **sugar** from the West Indies, and then **cotton**, with the coming of which Liverpool's history became peculiarly its own. The first **dock** was constructed two centuries ago: its site is now occupied by the custom house. To-day, a great row of docks occupies the eastern side of the narrowing estuary for a distance of six miles, the more northerly ones lying in **Bootle**. In the Wirral peninsula opposite, the little river Birket, rising close to the Dee estuary, and flowing to that of the Mersey, expands at its mouth into a wide and deep basin, the **Great Float**, which serves as a large natural dock. Around this stand large ship-building and engineering works, and it forms the centre of the town of **Birkenhead**. From an industrial point of view these towns are really one with Liverpool.

Imports and exports.—The Mersey is one of the great starting-points of the Ocean liners to New York and many other American ports. Its great imports are (1) **raw cotton** from the Southern States, (2) **grain** from the prairies of the States and Canada, (3) **rubber** from South America, (4) **meat** from North and South America, (5) metallic **ores**, chiefly of

copper, from North America, (6) **wool**, (7) **timber** from Canada, (8) **cattle** from the Western States, and (9) **tobacco** from the Southern States. Its chief exports are (1) **cotton goods** from Lancashire, (2) **machinery** and other metal manufactures from the Black Country, Lancashire and Yorkshire, (3) **woollens** from Yorkshire, (4) **chemicals** from Lancashire and Cheshire. It also carries on a large trade with Ireland. While Liverpool is above all things a port, there is a certain number of subsidiary industries dependent either upon the needs of shipping or the raw



FIG. 68.—PEAT-DIGGING AT KIRKBY MOSS, NEAR LIVERPOOL.

The natural surface of the ground is seen on the right; the cut blocks of peat on the left. The trees show the influence of the prevalent south-westerly wind.

From a photograph by Dr. A. Wade.

materials imported. Chief among the former is the ship building industry of Birkenhead; among the latter are tobacco-factories and many large flour-mills.

Communications.—A series of mosses (Figs. 64 and 68), in continuation of those of the Cheshire Plain, at one time isolated the south-western part of Lancashire to a large extent from the rest of the county; and though railways have broken the barrier there is still a difference between industrial Lancashire and the quieter towns and villages near Liverpool.

In the absence of good roads, Liverpool depended for inland communication, first on canals, and afterwards on railways. To this day, a cycling map shows that there are no first-class roads leading out of Liverpool, though several start from Birkenhead.

It is on the Wirral side of the Mersey, north and east of Birkenhead, that the suburbs of Liverpool are spreading ; such places as New Brighton being as accessible to the docks as are the eastern outskirts of Liverpool. The two sides of the Mersey are connected by services of large ferry-boats, steaming to and fro not only all day but through the night as well. A tunnel under the Mersey also allows of a frequent railway service between Liverpool and Birkenhead.

Lancashire coast.—The bottle-necked shape of the Mersey estuary increases the force with which the tidal wave rushes through. This prevents the silting-up which has destroyed the importance of the Dee estuary and Chester. The Mersey is in fact the only point suitable for a great port for long distances on this coast, most of which, being a part of the Great Red Plain passing under the sea, is low and shelving, so that in many parts long stretches of sand are exposed at high tide. The prevalent south-westerly winds, blowing on-shore, have heaped up great sand-dunes, which some way north of Liverpool attain a height of over 70 feet. **Morecambe Bay** is extremely shallow, and although on the map it seems to cut off the Furness district on the north from the rest of Lancashire, this is only the case at high tide : at low water, Lancashire is a continuous county. **Lancaster**, once a bridge-port and a Roman station, has suffered the same fate as Chester ; but is still the county-town.

Where rivers flow out to sea across these sandy shallows they form channels for navigation, and as the great population of Lancashire creates a need for other ports along the coast besides the main port of Liverpool, docks have been made at **Preston**, on the Ribble, Fleetwood on the Wyre, Glasson on the Lune, and at Heysham and Barrow on the extreme edges of Morecambe Bay. These are chiefly concerned in cross-channel traffic to and from Ireland and the Isle of Man : none of them

possesses the free and deep entrance necessary for great ocean liners. **Fleetwood** is the chief fishing-port on the English coast of the Irish Sea.

Another need of a great population has led to the growth of pleasure-towns along the sea-side. Chief of these are **Blackpool**, and **Southport** on the Lancashire coast.

LESSON XXXVIII.

THE LAKE DISTRICT.

1. Make a geological sketch-map of the area of Fig. 69, south of the Solway Firth and west of the main line of watershed, grouping the formations shown on the geological map thus :

- (1) Igneous and ancient rocks.
- (2) Carboniferous Limestone.
- (3) Coal Measures.
- (4) New Red Sandstone.

Compare this sketch-map with Fig. 69. Which formation occupies the chief areas of low ground ?

2. Make a sketch-map of the river-system of the Lake District, drawing only the rivers (as thin lines) and the watersheds (as thick lines). Add as many minor watersheds as you can to those shown on Fig. 57. From what point or points do the rivers and watersheds radiate ?

3. Make a sketch-map of the main Pennine watershed from lat. 55° N. to lat. 54° N., showing the watershed-line and the rivers flowing from it on each side.

In what directions do the chief rivers flow (*a*) on the eastern side, (*b*) on the western side ?

With what type of watershed is such an arrangement of rivers associated ?

What features do the contour-lines show in that type ? Which portion of the Pennine watershed shows those features ?

4. Make a sketch-map to show the course of the following railways, and write a short description of each :

D.G.

N



FIG. 69.—RIVER-BASINS OF NORTH LANCASHIRE AND THE LAKE DISTRICT. Contour-lines at 500 and 1000 feet above sea-level. The dotted lines near the coast mark the level of low water at spring tides.

(1) L.N.W.R., from Wigan (W.) through Preston (P.), Lancaster (Lc.), Carnforth (Cf.), Burton (B-in-K.), Kendal (K.), Shap Fells, and Penrith (Pr.) to Carlisle (Cl.).

(2) Furness and other railways, from Carnforth, across the estuaries of the Kent and Leven and passing near Cartmel (C.), to Dalton-in-Furness (D.-in-F.), with a branch to Barrow (B.-in-F.), and through Askam (Ak.), Broughton (B.-in-F.), Millom (Ml.), Whitehaven (Wh.), Workington (Wk.), Maryport (My.) and Wigton (Wt.) to Carlisle.

(3) Midland, from Skipton (S.) through Settle (Se.), Blea-moor Tunnel, Kirkby Stephen (K.S.), Appleby (Ap.) and Kirkoswald (Ko.) to Carlisle.

Some of the watershed-crossings of the Midland line are not marked on the map, but can be easily inferred. The highest point on the line is 1160 feet, a little north of the tunnel.

Compare the first and second of these lines from Carnforth to Carlisle as regards (*a*) length of line, (*b*) gradients. Compare the first and third as regards (*a*) actual number of watersheds crossed, (*b*) physical difficulties which the country presented to construction.

5. Make a sketch-map of the Lancashire and Cumberland coast-line, distinguishing the parts with fairly deep water near the coast from those where the sea-bottom shelves gradually.

Give reasons, if you can find them from the map, for the following facts :

TRADE OF LANCASHIRE AND CUMBERLAND PORTS, 1905.

	Total value of Imports and Exports.	Tonnage cleared.
	£1000	1000 tons
Carlisle, including Silloth	97	—
Maryport	774	100
Workington, including Harrington	27	
Whitehaven	87	—
Barrow, including Askam and Millom	1,142	125
Lancaster, including Glasson Dock and Morecambe	128	—
Fleetwood	534	39
Preston	918	—
Total of above ports	3,707	—
Liverpool	277,581	6,933

6. Make a sketch-map of the Lake District, bounded by a curved line so as to include Maryport (My.), Penrith (Pr.) and the Lune Valley. Show lakes, rivers and watersheds, and shade lightly all ground over 500 feet, without attempting to leave the narrow valleys unshaded. Mark by crosses the position of the chief iron-mines, and by a dot that of each blast-furnace, as shown in the following table :

	Production of Iron-ore, 1906.	No. of furnaces in blast, 1906.
	1000 tons	
Maryport (My.) - - - -	—	2
Workington (Wk.) - - -	—	14
Harrington (Hn.) - - -	—	2
Cleator Moor and Frizington (C.M.)	236	2
Egremont (Em.) - - - -	226	—
Barrow-in-Furness (B.-in-F.) - -	—	6
Millom (Ml.) - - - -	526	3
Askam (Ak.) - - - -	378	—
Ulverston (near D.-in-F.) - -	—	2
Carnforth (Cf.) - - - -	—	2

7. What general statement can you make as to the position of the iron-mines and furnaces of this district? How can you explain the large number of furnaces at Workington? Refer to the geological map.

The Lake District.—When the Ribble is crossed northwards, a part of Lancashire is entered quite unlike the industrial district on the south. The group of moors north and east of the Ribble looks very similar on the orographical map to those on the south, but only tiny villages are seen among them, no main roads or railways; and the geological map gives the explanation—there is no coal here. These moors come farther west, and at the same time the sea comes farther east in the large bay of Morecambe. Thus, in place of the broad plain of South Lancashire there is only a narrow lowland, and this is cut off to the north by a great uprising mass of high ground—the mountains of Westmoreland and Cumberland.

This uprising mass is somewhat dome-shaped, and its streams arranged in a fairly regular radial manner, without any one main watershed. Near the centre from which the watersheds radiate **Helvellyn** rises to 3118 feet above the sea. A still higher point, however, comes on the ridge running to the south-west (**Scafell**, 3210); while **Skiddaw**, on a ridge to the north, attains 3058 feet. The streams have deep valleys, and many of these are occupied by very deep, long and narrow lakes. These lakes, of which Windermere, Derwentwater and Ulleswater are the most famous, and Wastwater the deepest, add greatly to the beauty of the mountain scenery, and the whole region has been called **The Lake District**. It is a favourite resort of tourists in the summer, but a great drawback to its enjoyment is the extremely heavy rainfall—Seathwaite, on the northern side of the pass that leads from Wastwater to Borrowdale and Derwentwater, has the heaviest recorded rainfall (131 inches annually) in England.

Resemblance to North Wales.—The rocks which form the mountains of the Lake District are similar to those of North Wales, and as the two areas are similar in their mountainous character and climate, it is not surprising to find other points of likeness. Thus the Lake District shows the same signs of the action of ice in the past; roofing-slates are quarried in Borrowdale (near Derwentwater) and elsewhere; and sheep-grazing is the chief industry. The ratio of sheep to area is nearly the same as in Carnarvonshire, though less than in some other counties of Wales. Another resemblance is that Manchester draws its water-supply from the Lake District, though not in this case from an artificial lake but from Thirlmere.

There is yet another resemblance to be noticed. A large part of the lake district lies within the county of Cumberland, and the mountains are known as the **Cumbrian mountains**. These names remind us of Cymry or Cambria, the name of Wales; and here is found a native population of race similar to the Welsh. The place-names, however, with the exception of a few such as Penrith and Penruddock, are unlike those of Wales. Streams are called **gills** and **becks**; lakes are **tarns**, **meres** or waters; and high bare moors are **fells**.

Mining.—On the north-west of the lake district, along the shores of the Solway Firth, is a coalfield, the mines in which are carried far under the sea. Busy towns have arisen at **Whitehaven**, Workington and **Maryport**, where the coal is shipped. On the north and north-east lies a broad lowland of New Red rocks, the plain of Carlisle and the Vale of Eden. Along the south-west margin is a narrow New Red lowland, cut into by the estuary of the Duddon, and separated from the Lancashire plain by Morecambe Bay. Here, in the Furness peninsula, between the Duddon and Leven estuaries, the discovery of rich iron ore has led to the growth of a large iron-smelting town and port, **Barrow-in-Furness**, its harbour protected by Walney Island. A second iron-mining and smelting district is on the coast farther north, around **Workington**, owing its origin to local ore-deposits, though now importing much Spanish ore.

In the Skiddaw and Helvellyn areas, much lead- and zinc-ore is mined—another point of resemblance to North Wales.

Another mining industry was once important, on a small scale: **graphite** (blacklead) was obtained from Borrowdale (the valley running northwards from near Scafell to Derwentwater), but the mines are now exhausted. Yet an industry—the manufacture of **pencils**—originally dependent on these mines still persists, through industrial inertia, at **Keswick**, though the graphite now used is imported.

Communications.—The Lake District stands up as a barrier to the traveller from England to Scotland. Railways can scarcely penetrate it: the only one that actually crosses it does so from east to west by the Derwent Valley (Cockermouth to Keswick and Penrith). One line creeps round the coast, sending branches up the valleys; but the main London and North Western Railway works round the eastern side, up the Lune valley and over the watershed at Shap Fell—a neck of high ground joining the Lake District to the Pennines—at 1000 feet above the sea, then down to the Vale of Eden at Penrith.

The most important town in all this region is **Carlisle**. The prefix Car (as in Cardiff and Carnarvon) denotes that it was a

castra or Roman fortress ; while the different modifications that the Latin word has undergone in the names Carlisle, Lancaster and Chester respectively, shows that tribes speaking different languages or dialects lived around the three. Carlisle commands not only the mouth of the Eden Valley and the head of the Solway Firth, but also a very important route across to the east coast, as will be seen later. It is a county- and cathedral-town and an important railway-junction ; but it has lost the importance that it once had as a port, owing to the silting-up of the Solway Firth. Thus the three chief Roman stations of the Irish Sea coast have had a similar fate.

LESSON XXXIX.

THE PENNINE AXIS.

1. Examine Fig. 70. What is the scale ? At what intervals are contour-lines drawn ? Where is the lowest ground shown on the map ? Where is the highest ?

2. What is the approximate altitude of Malham Tarn ? Estimate its area. Which side of the tarn has the steepest shore ? Which has the flattest ? Which is the inflowing and which the outflowing stream of the tarn ? How far does the latter flow before it disappears ?

Formerly, after heavy rains, the underground channel of the stream could not carry all the water, and it then continued in a stream above-ground.

Make a sketch-map of Malham Tarn and the head-waters of the Aire, marking this ancient wet-weather stream by a dotted line. What is the length of the underground course of the stream (assuming it to flow in the same direction as the dry valley at the surface) ?

3. Make a tracing of the whole map, inserting alternate contour-lines only, and stream-courses. Show by dotted lines the probable continuation underground of all streams that disappear, making them follow the courses that they would have if above ground. Shade ground above 2000 feet heavily, between 1500 and 2000 medium, between 1000 and 1500

lightly, and leave it unshaded below 1000. Draw in the principal lines of watershed.

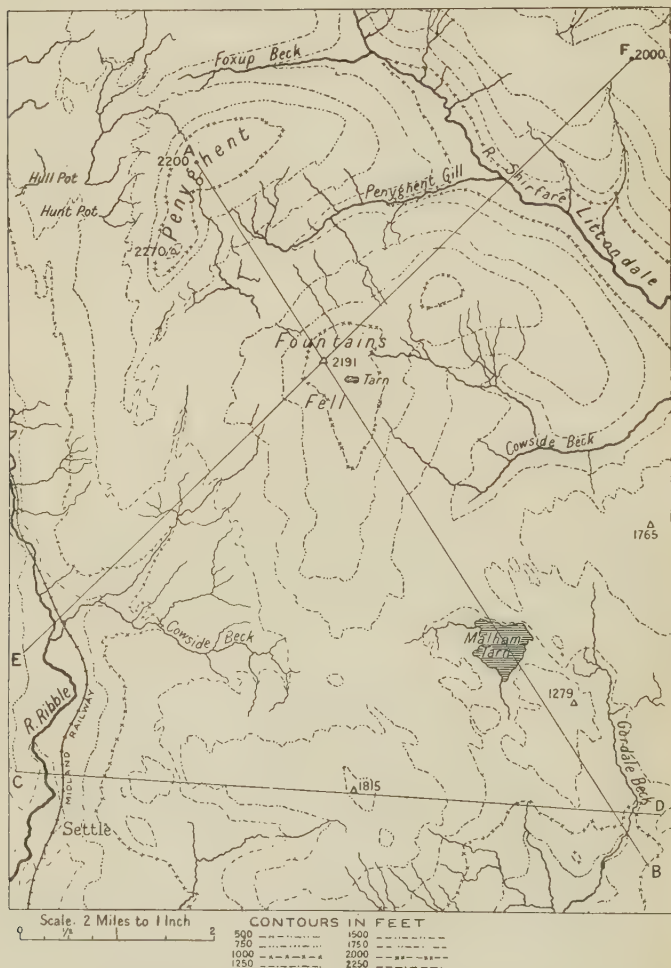


FIG. 70.—PENYGHENT AND MALHAM TARN.

For *Shirfare* read *Skirfare*. Hull Pot and Hunt Pot are more correctly named Thirl Pot and Thund Pot.

4. Draw sections along AB, CD and EF, making both horizontal and vertical scales 3 inches to a mile.

5. Using the table given below, calculate the yield of limestone per 100 acres of area in each county.

THE CHIEF LIMESTONE-PRODUCING COUNTIES (not including Chalk).

	Area.			Area.	
	1000 acres	1000 tons		1000 acres	1000 tons
Durham -	646	2068	Lancs -	1183	554
Derby -	646	1844	Cumberland	962	548
Yorks -	3870	1096	Carnarvon -	362	434
Devon -	1666	574	Glamorgan	515	403
Somerset -	1035	562	Brecon -	466	353

On an outline county map of England and Wales, shade those counties yielding over 200 tons per 100 acres darkly; from 100 to 200 tons, medium; from 40 to 100 tons lightly; leaving the rest unshaded.

6. On an outline county map of England and Wales (or of the British Isles) indicate by dots the number of thousand tons of lead ore in each county; and similarly for zinc ore with crosses. What geological formations occur in the counties in question?

CHIEF LEAD- AND ZINC-ORE-PRODUCING COUNTIES, 1906.

	Lead-ore.			Lead-ore.	
	1000 tons	1000 tons		1000 tons	1000 tons
Flint -	6	4	Carnarvon -	0	1
Derby -	6	1	Isle of Man -	3	2
Durham -	4	0	Lanark -	2	0
Montgomery -	2	0	Dumfries -	1	0
Westmoreland	1	0	Donegal -	1	0
Cumberland -	1	6	Other counties ¹	3	3
Denbigh -	0	3	Total -	31	23
Cardigan -	1	3			

7. Examine the geological map: what limestone is found in all the counties shaded in Exercise 5? What other limestone is found in Durham?

¹ Northumberland, Shropshire, Cornwall and Montgomery raise both lead and zinc-ore; Yorkshire, Somerset and Carmarthen raise lead-ore.

The total production of limestone in England and Wales is over 11 million tons. What fraction of this comes from Durham and Derbyshire? There are also nearly 5 million tons of chalk raised. What statement can you make as to the three geological formations that are most useful as a source of lime?

8. There are lead-smelting works at the following places in England and Wales. Divide them into those situated near lead-mines, and those that are not, and account for their presence in as many as possible of the latter—Derbyshire (Bradwell and Matlock), Durham (Consett and St. John's Chapel), Bristol (2), St. Helens (2), London (2), Newcastle-on-Tyne (5), Somerset (Priddy), Birmingham, Westmoreland (Patterdale), Leeds and Pateley Bridge (Yorkshire), Swansea (4), Burry Port (Carmarthen), Bagillt (Flint).

Account similarly for the situation of zinc-smelting works at Northwich (Cheshire), Wrexham, Swansea district (6) and Bristol.

The backbone of England.—A journey has now been made right up the west coast of England, and all the way from Cheshire there has been high ground to the east. This high ground is often called the Pennine Chain, but it is not a chain of mountains: it is rather a high plateau in which deep valleys have been cut by rivers, leaving high moorland standing up between them. As this forms the framework of the north of England it may be called the **Pennine Axis**. This band of high ground extends from the Cheviot Hills on the Scots border to Derbyshire, where it ends abruptly against the Trent valley. It is composed of Carboniferous Limestone and Shale, Millstone Grit, and other rocks older than the coal, and it is flanked on both sides for part of its course by coalfields, under which its rocks dip down.

A remarkable and very important feature of the Pennines is that the watershed lies towards its western margin, and the highest points also lie there (**Cross Fell**, nearly 2900; **Mickle Fell**, 2591). Some of them even lie west of the watershed itself (**Whernside**, 2414, and **Ingleborough**, 2373). The Lake District, still farther west, rises to even greater heights. The

consequence is that the western rivers have a steeper fall and are shorter than the eastern: yet there is less difference in these respects than there might be, because the eastern rivers flow fairly straight out towards the sea, while the western rivers tend to flow north or south for some way before turning west.

Rivers.—The eastern rivers have cut for themselves deep valleys in the moorland, which are called **dales**. Thus the Tyne, Wear, Tees, Swale, Ure, Nidd, Wharfe and Aire flow in **Tyndale, Weardale, Teesdale, Swaledale, Yoredale** (or **Wensleydale**), **Nidderdale, Wharfedale** and **Airedale** respectively. The first three of these rivers flow separately to the sea, the rest, having the Cleveland and Hambleton Hills and Yorkshire Wolds to stop their direct course eastwards, turn south in the plain of York and unite into a single river, the **Yorkshire Ouse**, which falls into the Humber.

South of the Aire comes its tributary, the **Calder**, its valley thickly set with large industrial towns. South of this the watershed bends to the east, and the next important river to the south, the Don, has no dale; it flows down the dip-slope of the Millstone Grit, and leaves the moorlands a small stream. A number of tributaries from the same dip-slope join it near Sheffield, and thence it flows north-eastwards into the Humber.

The remainder of the moors to the south form what is known as the **Peak District**, in Derbyshire and East Staffordshire—a district noted for its beautiful scenery, and as being a favourite tourist country; with mineral springs, at Matlock and Buxton. It is drained mainly by two rivers draining south to the Trent, the broad valleys of which are **Dovedale** and **Derwentdale**, the latter being the low ground at the foot of the Millstone Grit escarpment.

Limestone scenery.—In the areas of Carboniferous Limestone the Pennine moors resemble the Mendip Hills in many ways. Thus, **caverns** and **underground streams** are common. Many of the caverns have been inhabited in the past. In the Victoria cavern, near Settle, there were found in successive layers on the floor, first the remains of the tools and ornaments of people who lived in or since the Roman period; below these, the flint-

weapons of a much earlier time ; and still lower the bones of cave-bears and hyaenas. Similar discoveries have been made in caves in various parts of the country where thick masses of limestone occur.

Only where grit or shale forms the subsoil are surface-streams usually found. On leaving one of these areas to enter the limestone area, the streams often disappear into deep holes which they have made by dissolving the limestone : these



FIG. 71.—MALHAM COVE.

The dry valley leading down from Malham Tarn ends at the top of the limestone cliff.
The Aire issues from its underground channel at the foot of the cliff.

From a photograph by Prof. S. H. Reynolds.

are called **pots** or **pot-holes** (Fig. 70). The little stream which forms the head-waters of the river Aire rises not far from Ribblesdale (the Ribble valley) and within a mile flows into a little lake called **Malham Tarn**, which lies upon ancient rocks (Fig. 70). Emerging from this, in a very short distance it reaches the limestone area, and disappears into a subterranean passage, from which it reappears at the foot of a cliff nearly 300 feet high. A dry valley continues the course of

the stream above ground ; and at one time this used to be occupied, after heavy rains, by a stream (like a winter-bourne, p. 77), which fell in a cascade over this cliff (Fig. 71) ; but this has not happened for over a century, the underground channel having been enlarged by solution.

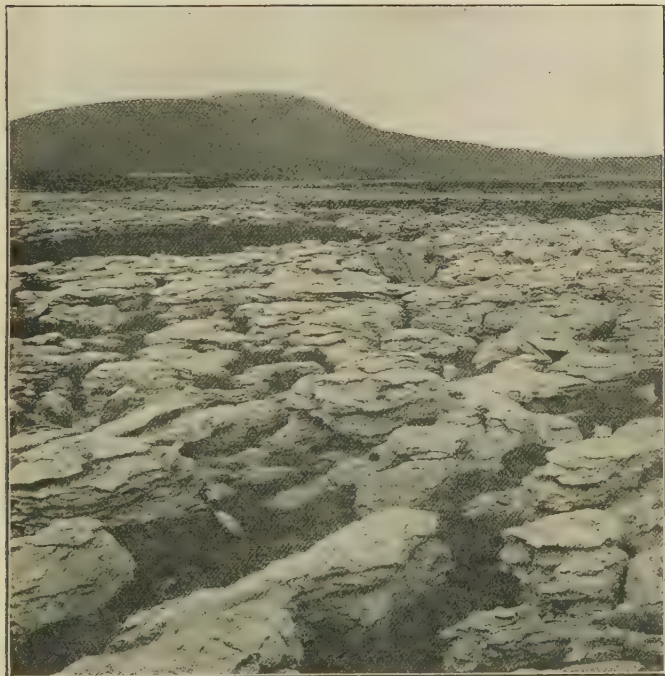


FIG. 72. — WHERNSIDE.

The mountain is seen rising from a plateau consisting very largely of bare limestone.
From a photograph by Mr. H. Edwards.

Another resemblance to the Mendips is the large number of sheep ; and again, the presence of veins of lead ore. Lead-mining is chiefly carried on at the two ends of the Pennine axis, in Weardale (and elsewhere) in the north, and Derbyshire in the south. The limestone is extensively quarried, for lime-

burning, for a flux in iron-smelting, and for building-stone. Some varieties form handsome marbles when polished, and are much used for chimney-pieces and table-tops: such are the Ashford marbles of Derbyshire, the Dent marble of Yorkshire and the Frosterley marble of Durham. Excellent sandstone is also quarried at Bakewell and elsewhere.

As the geological map shows, it is in the northern and southern parts of the Pennines that limestone predominates. In the central part, which lies between the Lancashire coalfield and the broadest and busiest part of that of Yorkshire, Millstone Grit is the principal formation. Here is the most typical moorland scenery—heathery expanses with abundant streams and occasional bogs. In the limestone area to the north, some of the highest points (as Whernside and Penyghent) consist of outlying masses of the Millstone Grit resting upon the Carboniferous Limestone. The difference in the aspect of the two formations is very striking (Fig. 72).

LESSON XL.

THE PENNINE AXIS (*Continued*).

1. Make from Fig. 73 a sketch-map of the watersheds in the area over 500 feet above the sea. Fill in as many minor-watersheds as you can. Mark the position of all the railway-tunnels shown on the map, and also the following:

Doveholes Tunnel, M.R., between Tideswell (Tw.) and Chapel-en-le-Frith (CF.);

Clay Cross, M.R., under the watershed between Alfreton (Af.) and Chesterfield (Ch.);

Dronfield (or Bradway), M.R., between Chesterfield (Ch.) and Sheffield (S.).

Morley, L.N.W.R., near Morley (Mo.), and Queensbury, G.N.R., near Bradford (Bf.), between the Aire and Calder valleys;

Bramhope, N.E.R., between Airedale and Wharfedale, near Horsforth (Hf.);

Sough, L. & Y.R., between Bolton (B.) and Darwen (D.);

Harecastle, N.S.R., near Burslem (Bu.), Fig. 64.

2. The following table from Whitaker's *Almanack* gives a list of railway-tunnels over a mile long. Note the length of each tunnel on your sketch-map. What proportion of the whole list come within the Pennine region? Explain why so many of these railways have long tunnels, and why so many railways should have been constructed in country that presented such difficulties in construction.

PRINCIPAL RAILWAY TUNNELS.

	M.	Yds.		M.	Yds.
Severn (G.W.) - - -	4	624	Kilsby (N.W.) - - -	1	663
Totley (M.) - - -	3	950	Shepherd's Well (S.E. & C.)	1	616
Standedge (N.W.) - - -	3	62	Oxted (B. & S.E. Jt.) -	1	506
Woodhead (G.C.) - - -	3	17	Wapping (L'pool) (N.W.)	1	490
Chipping Sodbury (G.W.)	2	913	Sydenham (S.E. & C.)	1	440
Disley (M.) - - -	2	346	Clayton (B. & S.C.) -	1	440
Medway (S.E. & C.) - -	2	332	Cuffley (G.N.) - - -	1	408
Bramhope (N.E.) - - -	2	225	Drewton (Hull & Barnsley)	1	356
Festiniog (N.W.) - - -	2	206	Dronfield (M.) - - -	1	264
Cowburn ¹ (M.) - - -	2	182	Sough (L. & Y.) - - -	1	258
Sevenoaks (S.E. & C.) -	1	1691	Abbot's Cliff (S.E. & C.)	1	173
Rhondda (Rh. & Sw.) -	1	1683	Corby (M.) - - -	1	160
Morley (N.W.) - - -	1	1590	Honiton (S.W.) - - -	1	121
Box (G.W.) - - -	1	1467	Wenvoe (Barry) - - -	1	108
Catesby (G.C.) - - -	1	1240	Sharnbrook (M.) - - -	1	100
Dove Holes (M.) - - -	1	1227	Glaston (M.) - - -	1	82
Littleborough (L. & Y.)	1	1177	Merstham (S.E. & C.) -	1	70
Sapperton (G.W.) - - -	1	1040	Midford (Som. & Dor. Jt.)	1	53
Mersey (Mersey) - - -	1	940	Belsize (M.) - - -	1	62
Bleamoor (M.) - - -	1	867	Glenfield (M.) - - -	1	36
Polhill (S.E. & C.) - -	1	849	Claycross (M.) - - -	1	11
Queensbury (G.N.) - -	1	742	Harecastle (N. Staff.) -	1	3

3. Insert on the sketch-map the following railways. Write a verbal description of the course of each.

N.E.R., from Carlisle (Cl.) through Brampton (Bt.), Haltwhistle (Hw.), and Hexham (Hh.) to Newcastle-on-Tyne (N.).

N.E.R., from Penrith (Pr.) through Appleby (Ap.), Kirkby Stephen (K.S.), Bowes (Bo.), Barnard Castle (B.C.) to Darlington (Dl.), Stockton (S. on T.) and Middlesbrough (Md.).

Midland, from Leeds (L.) through Shipley (Sp.), Keighley (Kl.), Skipton (Sk.), Settle (Se.) to Lancaster and Heysham (Hs.).

L. & Y.R., from Manchester (M.) through Rochdale (R.), Morden (To.), Sowerby Bridge (S.B.) to Wakefield (Wf.).

D.G.

¹ Marked as Chinley tunnel on Fig. 59.

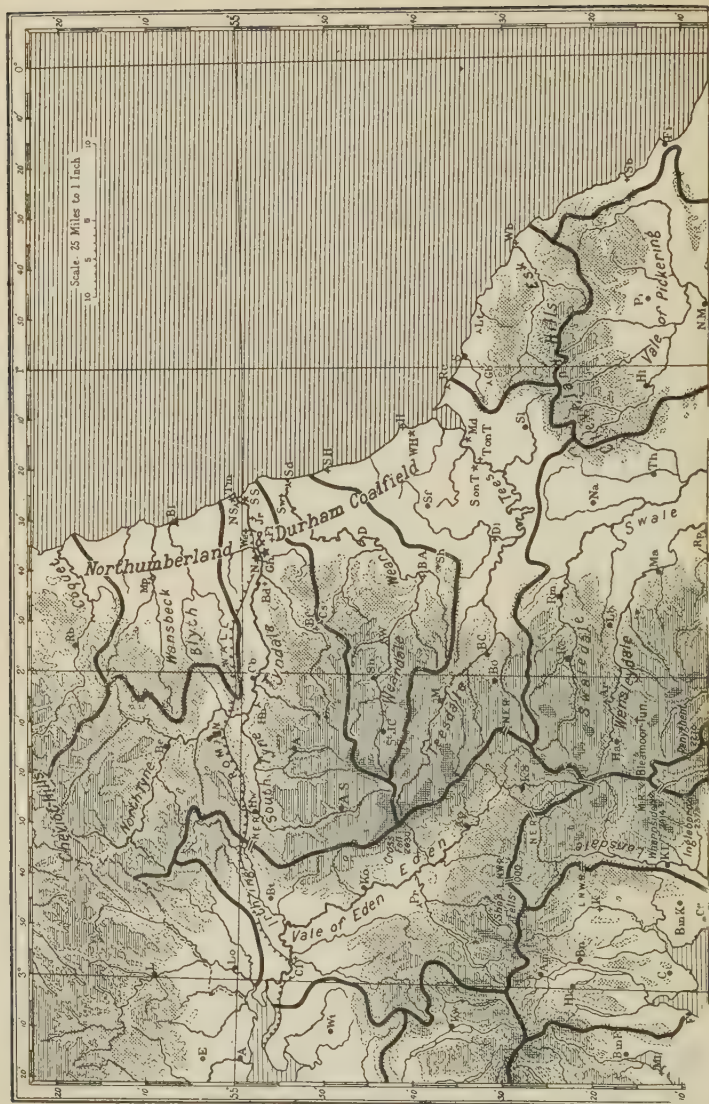




FIG. 73.—ENGLAND NORTH OF THE TRENT.
Contour-lines at 500, 1000 and 2000 feet above sea-level.

L.N.W.R., from Crewe (Cr.) to Stockport (Sk.), Staleybridge (St.), Huddersfield (Hf.) and Dewsbury (Db.) to Leeds.

G.C.R., from Manchester through Hyde (Hy.) and near Glossop (Gl.) to Sheffield (S.).

Midland, from Manchester, through Stockport and near Chapel-en-le-Frith (C.F.) to Sheffield.

Refer also to the descriptions already written of

L.N.W.R., Preston to Carlisle (Lesson XXXVIII.).

Midland, Settle to Carlisle (Lesson XXXVIII.).

A barrier.—The great importance of the Pennine axis lies in the fact that it separates two thickly populated districts. On the west lies the cotton-manufacturing district of Lancashire; on the east, the woollen-manufacturing district of Yorkshire, and farther north the great Newcastle coalfield. Between such areas there is naturally much trade and communication, to which the moorland acts as a barrier. Every pass over the watershed consequently becomes an important route, and the lowest passes the most important of all.

The deepest of all the notches in the watershed is at the head of the straight east and west course of the Tyne. Here it is separated from the Irthing tributary of the Eden by ground less than 500 feet above the sea. The importance of this pass is shown by the choice of it by the Romans for the line of their great wall made as a defence against the northern tribes, which still stretches across England for a distance of 60 miles from sea to sea, from Carlisle to Wallsend. At the present day, the pass contains the Newcastle and Carlisle railway.

Next in importance is the series of passes between the head of Airedale and Ribblesdale, at about 500 feet above the sea. The importance of these may be judged from the fact that while for the most part the boundary between Lancashire and Yorkshire corresponds with the watershed, the upper part of Ribblesdale belongs to Yorkshire instead of Lancashire. Along with the adjoining parts of Airedale and Wharfedale and the moors around, it constitutes the **Craven** district of Yorkshire. The chief railway here is the Midland line from Leeds and Bradford (Airedale) by Skipton and Settle to the west coast at

Lancaster and the Furness district. Branches connect this line with Wharfedale and with the Lancashire cotton-towns, and a very important and difficult line runs northwards, from Settle up the Ribble to its source, and over the watershed at a height of 1160 feet, to the Eden Valley for Carlisle and Scotland.

But the more important **trans-Pennine routes** are farther south, uniting the great cotton and woollen towns. The Lancashire and Yorkshire railway from Manchester and Rochdale to Halifax, passes from the Roch valley to the Calder valley by the Littleborough tunnel, $1\frac{3}{4}$ miles long. The London and North-Western (Manchester to Huddersfield and Leeds) passes from a tributary of the Mersey to one of the Calder by the Standedge tunnel, 3 miles long. The Woodhead tunnel, almost as long, carries the Great Central from another Mersey tributary to the Don, on its way from Manchester to Sheffield. The rival line of the Midland, coming farther south, where the Derwent valley interposes, requires two long tunnels—the Cowburn tunnel from the Goyt to the Derwent, over 2 miles long, and the Totley tunnel from the Derwent to a tributary of the Don, no shorter than $3\frac{1}{2}$ miles long.

Water supply.—There is another way in which the Pennine moors are of great importance to the industrial towns on either side; excepting only Manchester and Liverpool, they all rely upon the moors for their water-supply. The limestone regions, where so much of the rainfall disappears into caverns, is not suitable for reservoirs; but there are large areas where the rocks consist of grits and shales, as in North Wales. Here reservoirs can be made. The water, having no opportunity to dissolve calcium carbonate, is very soft, in striking contrast with the water-supply of London and other towns of the south and east, which is pumped out of the chalk, or abstracted from rivers that have flowed over a chalk or limestone district. Soft waters have two disadvantages for drinking purposes—they do not supply the lime that we require for our bones and teeth, and they tend to dissolve the lead of the pipes through which they may have to pass. The latter danger is increased when

the water collected on the moors contains the drainage from peat-mosses. Thus, bad teeth are very common in these districts, and lead-poisoning sometimes occurs. To obviate these dangers in some cases the water is hardened artificially by the addition of lime. On the other hand the users of soft water for washing have a great advantage over the users of hard water in respect of their soap bills and the wear of their linen, hard water being wasteful of soap. For dyeing, the soft, peaty water from the moors is particularly good, and has been a factor of some importance in the development of the textile industries of Lancashire and Yorkshire.

LESSON XLI.

THE WEST RIDING.

1. Make a percentage diagram to show the chief occupations of Yorkshire. Write down a statement of the most important Yorkshire industries, based on a comparison with the column for England and Wales; and another statement as to the differences you notice between the occupations of Yorkshire and Lancashire.

OCCUPATIONS OF YORKSHIRE, 1901.

Percentage of total occupied persons engaged in	Yorkshire.	Lancashire.	England and Wales.
Textile industries - - -	17	25	8
Metals and machinery - -	13	9	10
Mines and quarries - - -	8	5	6
Transport - - - -	8	10	9
Domestic service - - -	8	8	14
Building and construction -	7	6	7
Making apparel of all kinds -	7	7	8
Supply of food, lodging, etc. -	7	7	8
Agricultural - - - -	6	3	8
Other occupations - - -	19	20	22
	100	100	100

2. Make a series of percentage diagrams to illustrate (a) the share of wool, cotton and other textile materials in the total textile workers of Yorkshire; (b) the relative numbers employed in each of the processes of the woollen industry, including dyeing and bleaching (on the assumption that dyers and bleachers are divided among the several textile materials in the proportions of the total of other workers).

DETAILS OF YORKSHIRE TEXTILE INDUSTRIES.

	No. of thousands employed.		
	Males.	Females.	Total.
COTTON—Processes preparatory to spinning	1	2	3
Spinning - - - - -	6	5	11
Processes preparatory to weaving - -	3	5	8
Weaving - - - - -	6	8	14
Various - - - - -	2	1	3
			39
WOOL—Processes preparatory to spinning -	12	5	17
Spinning - - - - -	17	32	49
Processes preparatory to weaving - -	—	—	—
Weaving - - - - -	18	59	77
Various - - - - -	29	10	39
			182
SILK - - - - -	3	6	9
FLAX AND LINEN - - - - -	1	2	3
HEMP - - - - -	1	1	2
FUSTIAN - - - - -	1	0	1
MIXED MATERIALS - - - - -	4	7	11
Bleaching, dyeing, etc. - - - - -	13	1	14

3. Represent the relative employment of men and women in the Yorkshire woollen industry in the same way as for the Lancashire cotton industry (p. 185).

4. Draw two parallel vertical columns, $\frac{1}{5}$ inch broad, and a little over 6 inches high. Mark off divisions in one of these corresponding to the quantities of wool imported at the several ports named on p. 214 (1 inch = 100,000,000 lbs.). Divide the other column similarly according to countries of

origin. Write the names of ports and countries in appropriate places.

What do the columns suggest as to the main source of the wool landed at each of the principal ports?

QUANTITIES OF WOOL IMPORTED, 1905.

By Port of Entry.	Million lbs.	By Country of Origin.	Million lbs.
London - - - -	430	Australia and New Zealand	393
Liverpool and Manchester	103	British East Indies - -	40
Southampton - - -	32	South Africa - - -	68
Hull, Goole and Grimsby	46	South America - - -	51
Other ports - - - -	12	Europe and Mediterranean	60
		Other countries - - -	8

5. Make percentage diagrams for the imports of wool and exports of woollen goods, showing the shares taken by the chief ports.

How do you account for the importance of Dover, Folkestone and Harwich in export, and their unimportance in import of wool?

WOOLLEN YARN AND MANUFACTURES EXPORTED, 1905.

	£1,000,000.
Liverpool - - - - -	9
London - - - - -	5
Hull, Goole and Grimsby - -	6
Dover and Folkestone - -	5
Southampton - - - -	1
Harwich - - - - -	1
Scotch ports - - - - -	$\frac{1}{2}$
Other ports - - - - -	$2\frac{1}{2}$

The woollen industry.—The sheep that graze on the Pennine moors supply wool to be spun and woven into cloth in the valleys. When Flanders became the chief weaving country, English sheep-rearing was greatly developed for the export of wool to Flanders. The Flemish weavers, when driven from their own land, settled to a great extent in the West Riding,

where the many small streams supplied the water-power by which their looms were driven. With the introduction of coal as a source of power in the latter part of the eighteenth century, the woollen industry concentrated itself in factories on the Yorkshire part of the great coalfield that flanks the south-eastern part of the Pennine axis, just as the cotton industry concentrated itself on the coalfield on the opposite side. Were it not for the presence of great stores of coal, the woollen industry here might have remained as small as that of the Cotteswolds, or have died out like that of Salisbury Plain. As it was, there grew up the great towns of **Leeds** at the mouth of Airedale, and **Bradford** on a tributary valley higher up; and on the Calder valley or tributaries of it, **Wakefield**, **Huddersfield** and **Halifax**. Many smaller places, but still towns of large size, may be found marked on the map. All these towns are engaged in the woollen industry primarily, each town generally specializing in some particular quality of goods. Thus, Leeds has the greatest ready-made clothing industry in Britain; Bradford weaves more mohair than any other place in the world; Halifax has the largest carpet-factories in the world; Huddersfield weaves broadcloth and other cloths; and the towns of the Spen Valley—Dewsbury, Batley and others—produce shoddy. Although woollens are the staple product of the West Riding, there is a considerable cotton-industry also in Bradford.

It is not on the sheep of the Pennines that the West Riding now relies for its wool. The principal supplies come from Australia, New Zealand, the Argentine, and Natal. The Australian wool is landed in the London docks, Argentine wool at Liverpool, while what is imported from Central Europe comes to Hull. The manufactured goods are exported by Hull to Europe generally, and by Liverpool to other parts of the world. Thus one great use is seen for the railways across the Pennines, as well as for the easier lines connecting with Hull and London.

Coal and iron.—Though woollens form the staple industry of the district, there are many others. Coal is mined for

export to other parts of the country (Silkstone, the name of a village near Barnsley, is well-known to coal-users).

Although the local production of iron ore is small in comparison with that of Cleveland, much is obtained (as in South Staffordshire) from the coal-mines; and there are great smelting-furnaces and engineering works at Leeds. In the area between Bradford, Halifax and Huddersfield, valuable **fire-clay** is dug and made into bricks to be used in glass-works for the "pots" in which the glass is melted. In the same district, a kind of sandstone called **gannister** is dug and used for moulds in metal-casting, as well as for mixing with fire-clay in brick-making. At Penistone and at Hipperholme and Northowram near Halifax, the Coal-measures yield slabby sandstone of great value for **paving-stones**, door-steps and window-sills, and there is also manufactured artificial stone; both this and the natural stone being exported all over the country for paving and building. At Castleford, where the Calder joins the Aire, there are very large glass-works.

Farther south, near **Sheffield** and **Rotherham**, the sandstones are more particularly useful as **grindstones**, for sharpening steel tools. Here too the small streams rushing down the steep dip-slopes from Howden Edge (the Millstone Grit escarpment overlooking Derwentdale) afforded water-power for turning the grindstones, and thus led to the establishment of the great **cutlery industry** for which Sheffield is famous all over the world. Here steel of high quality is made in great furnaces, the smoke from which darkens the sky, and from the steel, knives, razors and all kinds of cutting instruments are made.

Besides cutlery, other articles of steel are made, particularly railway wheels and axles, springs and textile machinery; and silver and electro-plate goods are manufactured.

This coalfield, the largest in Britain, extends south to the Trent Valley. This southern portion was referred to in Lesson XXIII.: the coal here is mined for export and there are no important local industries or large towns. **Chesterfield**, in Derbyshire, with large engineering works, and a small textile industry, is the largest. The names of many of the mining

villages, such as Clay Cross, are familiar on coal-trucks in distant parts of England.

The part of the West Riding north of Airedale is outside the coalfield, and here there is only a small population. The textile industry has, indeed, spread beyond the actual coalfield, sewing-cotton factories being found as far north as Skipton; but most of the towns are either market-towns, as Settle, or healthy residential towns and holiday resorts for the busy people of the manufacturing towns. Chief among these is **Harrogate**, where mineral springs are found.

LESSON XLII.

YORKSHIRE.

1. Compare Fig. 74 with the geological map. Of what formations are the Plain of York, Cleveland Hills, Yorkshire Wolds and Vale of Pickering composed? State the facts in tabular form, and to each add the names of any other natural regions already met with which show the same geology and similar physical characters.

2. Tabulate a list of the right- and left-bank tributaries of the Yorkshire Ouse (taking that river as far as but not inclusive of the mouth of the Trent). Measure the approximate length of each, state where it rises, and name the important towns on its banks. Include in your table any secondary tributaries named on the map. What peculiar feature is shown by the Yorkshire Derwent?

3. Measure the areas of the Ouse, Aire and Don basins as marked on Fig. 74.

4. Make lists of the towns of over 100,000 population, of between 50,000 and 100,000, and of between 10,000 and 50,000, in each of the three river-basins just named.

5. Measure the direction and distance of the following places from Leeds and from Sheffield, and of those towns from one another:

Scarborough (Sb.), Hull (H.), Lincoln (L.), Chesterfield (Ch.), Huddersfield (H.) and Skipton (Sk.).



FIG. 74.—BASINS OF THE HUMBER RIVERS.
Contour-lines at 500 and 1000 feet above sea-level.

6. Refer to the geological map: what geological formations occupy most of the area of each riding? Write a list of them, and from this list and the above table make a list of characters in which (a) the East and North Ridings agree with one another and differ from the West Riding, (b) the

North and West agree and differ from the East, (c) all three agree.

If your map of England does not show the boundaries of the three ridings, you may draw them in roughly as follows: They radiate from York (1) along the Derwent to Filey, (2) along the Ouse to the Humber, (3) along the Ure to above Ripon, and then westwards along the southern watershed of the Ure to near Hawes.

Applying what you have already learned of the influence of the different geological formations and amount of rainfall on agriculture and industry, show, as far as you can, how the various points of agreement and difference can be explained.

THE RIDINGS OF YORKSHIRE, 1906.

	Percentage of				
	Cultivated Land in Total Area.	Arable Land in Cultivated Land.	Arable Land devoted to		
			Wheat.	Barley.	Oats.
East -	89.6	67	15	16	20
North -	63.8	39	9	21	20
West -	67.4	30	14	14	21

	No. per 1000 Acres of			Percentage of Total Area.		Rainfall.
	Population.	Cattle.	Sheep.	Wood.	Mountain. and Heath.	
East -	195	123	557	2.4	0.3	27
North -	183	129	503	4.3	23.0	27
West -	830	158	385	3.9	13.3	33

7. Describe and illustrate by a sketch-map the courses of the following lines of railway:

(1) Midland Railway, from Derby (a little south of this map) through Clay Cross tunnel to Chesterfield (Ch.), Sheffield (S.), Barnsley (B.), Normanton (Nm.), to Leeds (L.) and Bradford (Br.).

(2) G.N.R., from Newark (Ne.) through Tuxford (Tf.), East Retford (E.R.), Bawtry (Bt.), Doncaster (Dc.), to Wakefield (Wf.) and Leeds.

(3) N.E.R., from Doncaster to Selby (S.), York (Y.), Thirsk (Th.) and Northallerton (Na.) and Darlington.

(4) N.E.R., from York through Malton (N.M.) to Scarborough (Sb.).

(5) N.E.R., from Hull (H.) through Selby to Leeds.

Plain of York.—Between the Pennine moors on the west and the oolitic Cleveland and Hambleton Hills, and Chalk Wolds on the east, stretches the broad plain of York, much as the Cheshire plain stretches to the Welsh hills on the other side. It is as wide as the latter in the south (between 30 and 40 miles) but narrows to about one-third this width in the north, about Northallerton. It is lower and flatter than the Cheshire plain, not rising to 200 feet above the sea even at the watershed between the Ouse and Tees. The New Red Sandstone forms the foundation of the plain, but it is covered very largely with glacial deposits and alluvium, and now forms a rich agricultural land, though the central part was once the Forest of Galtres and the southern largely fen. There is still some fenland about Doncaster and Thorne, and peat is dug there.

Being the northward continuation of the plain of the lower Trent, it has always formed part of the chief route to Scotland, and has been of great importance from early times. At the head of the navigation of the Ouse, the Romans founded their chief military station of northern Britain, the city Eboracum, the name being modified by the English to Eoforwic, which in time became shortened to **York**. This is still the most important town of the plain, with 83,000 inhabitants—county-town, cathedral-city, a great railway-junction, market-town and miscellaneous manufacturing town.

The rest of the towns of the plain are small market-towns for the most part—Knaresborough, Thirsk, Northallerton and Yarm. **Doncaster** adds to this character that of an important railway-junction and the locomotive-making centre of the Great Northern Railway. **Selby**, though the bridge-town of the Ouse, is only a small ship-building town, the importance which it might have had having been taken by York.

The eastern moors.—The hills east of the Plain of York are arranged in two crescents—the escarpments of the Oolite and Chalk. The former escarpment faces northwards to the Tees at the Cleveland Hills (famous for iron-ore, p. 98), curves round to face the plain westwards as the Hambleton Hills, and southwards as the Howardian Hills. On the concave side this crescent encloses the alluvial **Vale of Pickering**, drained by the Yorkshire Derwent, a river remarkable for rising close to the sea and flowing away from it. There can be no doubt that this vale is an old lake-bed; it is probable that originally it was drained direct to the sea at Filey, and that in the glacial period this outlet was dammed up and a lake formed. The level of the water rose until it found an outlet to the plain of York near Malton, and the escaping water gradually cut a gorge here and in time drained the lake dry. Its dry bed forms a rich soil, and here are the agricultural towns of Malton, Helmsley and Pickering.

The Cleveland Hills form a high and bleak moorland given over (apart from their ore-mining) to sheep-grazing like other oolite hills. They abut on the North Sea in a cliffy coast, broken by little bays encircled by hills, each with a tiny fishing village built upon precipitous slopes. The only important places along this coast are the fishing-town of **Whitby** and the pleasure-resort of **Scarborough**.

The Wolds.—The Chalk escarpment faces the Vale of Pickering on the north and the Plain of York on the west. It is cut off by the sea in the high chalk cliffs of Flamborough Head. On its concave side it sinks down to the low alluvial ground of Holderness. This is an agricultural land once largely occupied by little lakes or “meres,” its few small towns, Bridlington, Great Driffield and Beverley, situated at the foot of the wolds; and Market Weighton at a gap in the wolds giving communication to the great plain.

The Humber.—Forming a natural boundary between Yorkshire and Lincolnshire is the broad estuary of the Humber, receiving the drainage of the New Red plain from the south as well as north, and so being the natural outlet for the commerce

of the whole of the North Midlands. The great port of the Humber is **Hull**—properly Kingston-on-Hull—with a population of over a quarter-million. This is less than one-third the population of the Mersey ports. Why? Because the Humber is well-situated for trade with the continent of Europe, but less convenient than the Mersey for the more important American and colonial trade. The Humber is also the natural port for the great Dogger Bank fisheries; but in this respect Hull is second to Grimsby (Lesson XXIV.), which has the advantages of being nearer the sea and also nearer by rail to London.

LESSON XLIII.

THE TEES AND THE TYNE.

1. Measure the lengths of the Tyne, Wear and Tees, and the areas of their basins.

2. Make a sketch-map of the district shown in Fig. 75; insert the railway (East Coast route to Scotland) from York through Darlington (Dl.), Durham (D.), Chester-le-Street (C.S.), Gateshead (Gh.), Newcastle (N.) and Morpeth (Mp.) towards Berwick.

Measure the distance of this line due west of the coast at each watershed-crossing. Why does this railway come nearer to the sea the farther north it goes? Write a description of its course.

3. Insert on the same map the two cross-country railways—
(a) from Newcastle, through Corbridge (Cb.), Hexham (Hh.), Haltwhistle (Hw.) and Brampton (Bt.) to Carlisle;

(b) from Darlington, through Barnard Castle (B.C.), Bowes (Bo.) and Kirkby Stephen (K.S.) to Tebay Junction, where it joins the L.N.W.R. on its way north to Shap and Penrith. Which of these two is the easier route?

4. Examine Fig. 76. What is the scale? What is the distance from Newcastle railway-bridge to the mouth of the Tyne (measured along the river)? What is the width of the river at Newcastle? At its mouth? How far (to the nearest tenth of a mile) is the 100 foot contour-line from the right and



FIG. 75.—BASINS OF THE TEES, WEAR, TYNE AND SMALLER RIVERS.
The broken line is the boundary between England and Scotland.
Contour-lines at 500 and 1000 feet above sea-level.

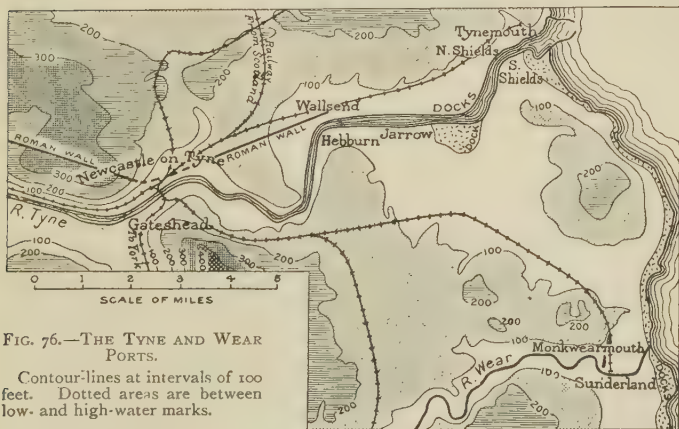


FIG. 76.—THE TYNE AND WEAR PORTS.

Contour-lines at intervals of 100 feet. Dotted areas are between low- and high-water marks.

Since this map was prepared a second railway-bridge has been made across the Tyne near the point marked by the "G" of "Gateshead."

from the left bank of the river, (*a*) at Newcastle, (*b*) at the point below Newcastle where the distance is least, (*c*) at Jarrow, (*d*) at North and South Shields?

Arrange your measurements in tabular form, and calculate the gradient in each case. Compare your results with those you have obtained in the case of the Thames and the Mersey (p. 25 and p. 189).

5. At what average altitude do the railways run on either side of the Tyne near Newcastle? What would you expect to be approximately the rail-level on the bridge across the Tyne?

6. Represent the following tonnage-statistics graphically on a small map of England and Wales by placing on each ship-building area a black circle with an area proportional to the tonnage.

The radius of the circle drawn must be proportional to the square root of the tonnage: the square root of 337 may be taken as 18, and that of 8 as 3, so that the largest circle will have 6 times the radius of the smallest.

Tonnage means the carrying capacity of a vessel; it is calculated on a basis of cubic capacity and has no real reference to weight, as the derivation of the word might suggest.

ENGLISH SHIP-BUILDING, 1907.

	No. of Vessels.	Tonnage.	Horse-power.
		1000	1000
Thames - - - -	270	18	111
Tyne - - - -	148	337	326
Humber - - - -	135	37	56
English Channel - -	124	8	62
Mersey to Solway - -	117	21	67
Wear - - - -	90	295	212
Tees (with Hartlepoons) -	83	240	118
Bristol Channel - -	61	8	$\frac{1}{4}$
Royal Dockyard - -	2	37	not engined

7. Calculate the average tonnage of a vessel built in each of the areas tabulated. Represent the results by a series of vertical lines of proportional length, arranged in order of length.

Durham coalfield.—The most northerly coalfield of England extends from just north of the Tees to the mouth of the Coquet. The Coal-measures actually form the coast-line between the Tyne and the Coquet, but though farther south they are shown on the geological map as separated from the coast by belts of magnesian limestone and red sandstone, they are present beneath these rocks and are mined close to the sea so far south as seven miles north of the Hartlepoons.

Two important rivers flow across this district from the Pennine moors—the **Tyne** and the **Wear**. A third, the **Tees**, is near its southern margin. The Tyne and Tees have fairly straight courses eastwards; but the Wear on emerging from the moors turns northwards for 15 miles, reaching the sea at last not far from the Tyne. The country at the foot of the moors here, though a continuation of the Plain of York, is much less level than that, the watersheds between the rivers rising to 300 feet even near the sea.

But for the presence of coal, this would be a thinly populated district, as it is not very fertile for agriculture. Even with the coal, it does not form a great manufacturing district like the Lancashire or Yorkshire coalfields, but is rather more comparable to South Wales, industrial towns being confined to the river-mouths, but these show much more variety in their activities than do the South Wales ports. The exports from these ports are also of a very varied character; but the imports, as in the case of South Wales, are mainly such things as grain and timber, for local use, not for distribution to other parts of the country like those of Liverpool or London.

Tees and Wear.—The Tees is a river which may be associated in the mind with iron. The great blast-furnaces of **Middlesbrough** are dependent on the ore of the Cleveland hills. Salt is also mined here from the New Red rocks, as in Cheshire and Worcestershire. At **Stockton** and the **Hartlepoons**, iron is smelted, coal exported, and there is some ship-building. Both at Stockton and at **Darlington** there are large engineering works. The same industries are found at the mouth of the Wear, except salt-mining; but ship-building is much more

important there, at **Sunderland**. On a cliff overlooking a loop of the river stands the ancient cathedral-fortress city of **Durham**.

The Tyne.—The busiest of the three rivers is the Tyne. Here is one of the greatest ship-building centres in the world. At **Elswick** the great ironclads for the Navy are built. Great quantities of coal are exported, not so much to distant places as in the case of the South Wales steam-coal, but to London and other ports along the coast. The trade in **sea-coal** from Tyne to London is far older than any other coal-trade, and has led to the familiar saying about “carrying coals to Newcastle.” Another famous export is that of **grindstones** and millstones. There are great **metallurgical works**, dependent in part on the mines of Weardale and Alston Moor; **chemical works**, which make use of the magnesian limestone that comes to the surface at the coast between Tyne and Wear; glass-works and engineering works.

Newcastle stands 8 miles up the Tyne, and is an ancient town (the castle was *new* when William the Conqueror built it) owing its importance as being at the lowest point where the river was easily crossed; in other words it is a **bridge-town** like London and Bristol. The ground rises steeply on either side of the river, across which both railway and road are carried on a famous high-level bridge. Hence to its mouth the river has been straightened and deepened to improve its navigation. The towns ranged along both sides form an almost continuous town, from Newcastle through Wallsend to **North Shields** and **Tynemouth** on the left bank, from **Gateshead** through **Jarrow** to **South Shields** on the right bank. The name of **Wallsend** recalls the fact that from this spot the Roman wall stretches across the land to Carlisle, reminding us that the Tyne owes some of its importance to its leading to the easiest pass across the Pennine axis. Wallsend is perhaps more familiar now as the name of a valuable house-coal, though the original Wallsend collieries are exhausted.

The coalfield extends along the coast 25 miles north of the Tyne, and at about half this distance stands the port of **Blyth**, which ships large quantities of coal. North of the coalfield the

country is thinly populated. It is the only part of the north of England that is not sharply marked off from Scotland, the boundary between the two countries being here, not a high watershed—which is a natural separator—but a river, the Tweed; and this fact tends to unite the people on the two sides. In early times the kingdom of Northumbria had its centre here, and included part of what is now Scotland as well as England north of the Humber.

LESSON XLIV.

ROADS, CANALS AND RAILWAYS.

1. With the help of the descriptions of railways you have already written, and by referring to "Bradshaw" wherever necessary, write brief descriptions of the following main lines of railway:

(1) Great Northern and North-Eastern—London to Berwick-on-Tweed.

(2) Midland—London to Manchester.

(3) Midland—Bristol to Carlisle.

(4) London and North-Western—London to Carlisle.

(5) Great Western—London to Chester.

(6) Great Western—London to Fishguard.

(7) Great Western—London to Penzance.

(8) London and South-Western—London to Plymouth.

2. Refer to the list of long railway tunnels on p. 207, and identify (with the help of the index to "Bradshaw" and the maps in this book) the position of as many as you can of those not within the Pennine region. Write a list of those you identify, and state against each the watershed under which it passes, and the geological formation of which it is composed.

3. Turn to a map showing the canals of England in your Atlas. Why does the Grand Junction Canal (London to Birmingham) follow the route of the L. and N.W.R. so closely in places, and take so much more roundabout a course near its southern end?

4. How many canals cross the Pennine Axis? Make a sketch-map to show them. With which railway crossings do

they respectively coincide? Describe the canal route from Leeds to Preston, and measure its length. What is the shortest railway-route between those places?

5. The Kennet and Avon Canal at Devizes is about 400 feet above sea-level. It descends to 200 feet in about a mile and a half by means of 20 locks. Of these, 16 are placed as close together as they can be, occupying a length of five-eighths of a mile. They are provided with reservoirs in place of the usual length of canal between.

From this information, calculate the maximum gradient along which a canal can be constructed.

Early roads.—Even in the days when Britain was a land unknown to the civilized world, peopled by tribes living a very primitive life, some means of communication between different parts of the country were necessary. Although every family produced its own food and clothing, they could not all dig their own ores, and with the use of metals extracted from ores, if not earlier, regular trade came about, and this trade required fixed routes. Accordingly we find that well-defined roads or tracks existed in Britain before the Roman conquest, and some of them still exist—partly as footpaths and partly as modern roads. The traders of those days seem to have found their easiest ways to lie along or under the crest of the Chalk escarpment, and the two best-preserved of these ancient tracks are (1) the **Pilgrims' Way** (Fig. 47) from Winchester to Canterbury and (2) the **Icknield Way** (Fig. 33) from the Marlborough Downs to Norfolk.

Roman roads.—The Romans were great road-engineers and made finer roads than have ever since been made in Britain. Their great ideal was straightness, and for the sake of this they were strangely ready to take a road over a steep hill, even when no great deviation would have enabled them to avoid it. Where the roads keep to level ground and have been preserved, they still form the finest available for the cyclist or motorist in the country. Yet even more remarkable than the endurance of the Roman roads is their frequent destruction. Portions of them have been ploughed over or otherwise destroyed. Sometimes

we find a straight piece of green lane that was once part of a great highway, but being now disconnected, is used only as a cattle-track perhaps.

Chief among the Roman roads are (1) **Watling Street**, which still runs almost unbroken from Dover, through London, St. Albans and Wroxeter to Chester; (2) **Ermine Street**, from London to Lincoln and York (Fig. 46); and (3) **Foss Way**, from Exeter, through Bath, Cirencester and Leicester to Lincoln. The names of these roads were given to them by the English in later times. It will be noticed that many of the towns on their courses still bear names which indicate a Roman origin.

It is not surprising that since the English let these grand roads go to ruin they did not make any for themselves. Our present system of roads grew up mainly by the linking together of tracks from one village to the next, and this is why they so often bend and twist as they pass through a village. Roads often make right-angle bends elsewhere, because they come down to us from a time when cornfields were more important than roads, and roads had to go round the boundaries of fields instead of the fields being fitted in between the roads. In the eighteenth century there was a revival of road-making, and this haphazard network of roads was improved by many short cuts and easier gradients; but even then no new roads were made on the Roman scale. The advent of railways stopped the improvement of roads for a time; but we may hope that cycles and motors will soon compel great undertakings of new roads.

Inland navigation.—In the days when English roads were at their worst, travellers made much more use of the navigable rivers than they do now. But rivers cannot take us over a watershed: for that purpose we must have artificial canals with locks. A **canal** differs from a river in being made in a series of horizontal reaches, at different levels, separated by **locks**. A lock is a water-basin closed by two gates, one leading to a reach at a higher level, and the other to the next at a lower level. Only one gate must be opened at a time. If a boat

wishes to pass from the lower reach to the upper, it enters by the lower gate, which is then closed. Water is admitted from the upper reach and the water-level in the lock rises until the upper gate can be opened and the boat pass on. The reverse series of operations take place when a boat passes in the opposite direction. Thus, instead of the water flowing continually down, as in a river, it only flows down when boats are passing through the lock. An ordinary canal reach receives at every passage of a boat as much water from the next higher reach as it loses to the next lower one; but a summit reach, *i.e.* one that crosses a water-shed, loses water in both directions. To prevent its running dry there must be large reservoirs, fed by streams from higher levels: this is not difficult as a rule, since the canal summit will always be one of the lowest points on the watershed. Where the descent from a watershed is very rapid (as in the Kennet and Avon Canal near Devizes) a series of locks in close succession may be necessary, and in place of the long reach between each there must be a side-reservoir, to prevent too great a fall of water-level.

The **Manchester Ship-Canal** has a duplicate set of locks suitable for large and small vessels respectively. This avoids the waste of water that would result from the too frequent use of the large locks.

The navigation of slow-flowing rivers can also be improved by the construction of locks; but in this case only a fraction of the total volume of the river flows through the locks. The rest is made to pass over an artificial waterfall, called a **weir**: this dams up the water sufficiently to fill the lock. The Thames is canalised in this way from Richmond up.

The English canals are not used as much as they might be, the introduction of railways having robbed them of much of their traffic, with the result that they have been greatly neglected.

Railways.—Unlike the roads, the railways of Britain are all quite modern, having been constructed within the last hundred years. Having been made for the deliberate purpose of carrying traffic for long distances as quickly as possible, they do

not as a rule present the patched-up character of our roads, though here and there we find some curious features that tell us that a line originally meant for local traffic only has been utilized in the construction of a more modern main line. In general, the arrangement of our main railway lines recalls that of the Roman roads, but they are more dependent on the contours of the ground, and to avoid steep gradients they sweep along in wide curves instead of straight lines. If a long straight line of railway is found anywhere (as in the Plain of York, or at the foot of the North Downs) it may be concluded that the ground there is very flat.

Like canals, railways must make use of low points on the watershed, but unlike canals they can be carried on a slope (provided it is not too great) and they more frequently make use of tunnels and viaducts: therefore they can be straighter.

The course of most of the important railways has already been traced for portions of their distance in earlier lessons. It remains only to link these sections up into continuous long-distance routes.

In the south-east of England, the overshadowing importance of London has made all the main lines radiate from it, and it is often the case that the quickest way to travel from one provincial town to another is by way of London, as on the more direct routes trains are slow and changes and waits are frequent. All these radiating lines (except those running eastwards) have to cross the horseshoe rampart of chalk that partly surrounds the London basin: they do so either by water-gaps or wind-gaps. The most important lines are those leading to the industrial districts of the Midlands and the North. These, after an easy course across the Oxford clay-vale, have to cross a second rampart—the Oolite or Marlstone ridge that forms the main watershed of the southern half of England. They then have a second easy course in the Great Red Plain: beyond which their routes are too varied to be generalized.

The most important long-distance lines are those from England to Scotland, three in number. The Pennine axis is

the controlling feature of the north of England, and defines the two most natural routes—the **east coast** and **west coast routes** as they are, not very accurately, termed, which follow the New Red Sandstone lowlands on either side. The Aire-Ribble gap and Eden valley make possible a third, much more difficult route, which joins the west coast route at Carlisle. While the eastern line, by keeping to the comparatively straight coast-line, finds a fairly easy path to follow, the indented west coast is far too roundabout a route, and inland the high ground of the Lake District and the Southern Uplands compels the west coast line to climb twice to 1000 feet above the sea, while between the two it descends almost to sea-level at Carlisle.

Roads, railways, canals and rivers and the sea are all useful means for the conveyance of goods and persons from place to place within the British Isles. Each has its advantages and disadvantages, which may be tabulated.

ADVANTAGES.

ROADS lead everywhere, as no other means of transit do, so that (except in rare cases) some part of every journey must be made by road, and if the whole is made by road the cost and trouble of transhipment are saved.

ROADS can be used by everybody.

ROAD-maintenance is not very costly and is a charge on the general funds of the nation, not on the traffic that uses the roads.

ROADS can be carried on steeper gradients and round sharper curves than railways or canals, so that their construction is much less costly.

DISADVANTAGES.

ROADS are adapted only for traffic on a small scale, where one man conveys at most a score of passengers or a very few tons of goods. The wages of carriers therefore bear a higher proportion to the quantities and values carried than those of railway engine-drivers and guards.

CANALS cost very little to maintain,—little more than the wages of the lock-keepers.

The water buoys up the weight carried, consequently the power required for hauling a given weight is far less than on a road or railway.

SEA-carriage has all the advantages of canal-carriage, with the addition that there are no locks, and no capital expenses except for wharves and docks.

RAILWAYS carry with much greater rapidity than any other means of transport.

They are adapted for the carriage of very large numbers of people or large quantities of goods under the control of a very few men.

CANALS are obliged to follow very devious courses in order to keep as much as possible on the level. This fact, with the delay in passing through locks, makes canal traffic very slow.

SEA-carriage is only available between sea-ports.

It is the most dangerous form of carriage, owing to the risk of sinking and wreck.

RAILWAYS are the costliest to construct of all means of transport. The high speed of trains necessitates a costly signalling system, and constant examination and repair of the way.

Thus for short-distance traffic of heavy goods, roads have the greatest advantage. Long-distance road-travel (by bicycle or motor) is rather a matter of pleasure than of economy. Canals are most suited for the carriage of such things as coal, bricks and other goods which are sold by the ton rather than by the pound, and can be kept a long time on the journey without loss. Railways are primarily adapted to the carriage of passengers, perishable goods, and goods sold by the pound rather than by the ton, to the price of which a railway rate of even many shillings per ton is a trifling addition. Nevertheless much coal and similar heavy traffic is also carried by rail: this is sometimes regarded as a wasteful method, but it is not really so, because the traffic to which railways are primarily adapted is concentrated on particular times and seasons, and to carry slower and cheaper traffic in between saves the waste of leaving costly lines and engines unemployed.

LESSON XLV.

COUNTIES AND TOWN-SITES.

1. On an outline county map of England and Wales colour or shade in one way all counties which appear to take their name from a town within the county, and in another way those that do not.

The following cases are difficult—Hampshire is really Southamptonshire; Wiltshire is perhaps Wiltonshire; Brecknock is another form of Brecon; Shropshire is certainly Shrewsburyshire; Cheshire is Chestershire, and Lancashire, Lancastershire. The rest should afford no difficulty.

2. On the same outline map, mark in the various portions of the county-boundaries by different coloured lines, according to the one of the following types to which they belong :

(a) River-courses.

(b) Watershed-lines. (To determine these, compare with the various watershed-maps in this book.)

(c) Approximately straight lines not coming under the two previous types.

(d) Irregular lines.

Compare the distribution of these four types of boundary with that of the two types of county, and, if possible, write some general statements of their relations.

3. Referring to your earlier practical work, and to any maps in this book, draw up a list of county-towns that come under each of the following heads :

(a) Sea-ports.

(b) Bridge-towns, *i.e.* towns situated at the lowest point where a river could (in former times) be bridged.

(c) Gap-towns, *i.e.* towns situated at a narrow water-gap in a range of hills.

(d) Pass-towns, *i.e.* towns situated either on a pass (wind-gap) across a watershed, or (more frequently) at the nearest suitable place in one of the valleys leading to the pass.

The following table gives the county-towns in cases where their name is not indicated by the name of the county :

County.	County-town.	County.	County-town.
Cornwall - -	Bodmin	Berkshire - -	Reading
Devon - - -	Exeter	Buckinghamshire -	Aylesbury
Somerset - -	Taunton	Suffolk - -	Ipswich
Dorset - - -	Dorchester	Norfolk - -	Norwich
Wiltshire - -	Salisbury	Glamorgan - -	Cardiff
Hampshire - -	Winchester	Merioneth - -	Harlech
Surrey - - -	Guildford	Flint - - -	Mold
Sussex - - -	Lewes	Anglesey - -	Beaumaris
Kent - - -	Maidstone	Westmoreland -	Appleby
Essex - - -	Chelmsford	Cumberland -	Carlisle
Middlesex - -	Brentford	Northumberland -	Newcastle

4. Make a similar series of lists for other important towns in England and Wales.

N.B.—It is quite possible for the same town to come on more than one of these lists.

County boundaries.—Incidentally throughout the preceding lessons it has been necessary to refer to the counties into which England and Wales are divided, because so much of the statistical information about agriculture, mines and quarries, population, etc., is prepared on a county basis. Yet counties are not as a rule natural divisions, and it is well to see how their boundaries came to be drawn as they are.

A large scale map shows that county-boundaries are of several different types :

(1) They are important river-courses, as the Thames, Stour, Waveney, Tamar, Wye and Mersey (but other equally important rivers do not form county-boundaries, as the Severn and Trent).

(2) They are approximately main watershed-lines, as the northern boundary of Sussex, the south-eastern boundary of Warwickshire, the division between South Lancashire and South Yorkshire, or the eastern margin of Cumberland and Westmorland.

(3) They are fairly straight lines which, without corresponding

closely to main watersheds yet avoid crossing any but very small streams. The most obvious boundary of this kind is that between Leicestershire and Warwickshire, which owes its straightness to its following the Roman road known as Watling Street. Other cases are the boundaries between Berks and Hants, Kent and Surrey.

(4) Lastly, we have lines bearing no relation to any natural feature whatever, twisting and zig-zagging in the most intricate fashion. Such are the boundaries between Bucks, Herts and Bedford; between Staffordshire, Worcestershire and Warwickshire. In these cases there are generally a number of outlying or "detached" portions of one county lying locally within another.

Divisions and unions.—Boundaries of the first three types were, in many cases, boundaries of kingdoms before they were boundaries of counties: they were settled at least roughly by treaty between one tribe and another. Such boundaries are very general among those counties which keep ancient geographical names, as Kent, Somerset, Dorset, Essex (the East Saxons), Sussex (the South Saxons), Surrey (the South Rigi), Norfolk and Suffolk (the North and South Folk of the East Angles). The fourth type of boundary is especially characteristic of those counties the names of which are taken from the names of their county-towns. The meaning of these intricate boundaries is best understood by noticing that they are just like the boundaries of many parishes within the counties: they were probably originally settled for convenience in cultivating the land. They are, in fact, agricultural boundaries that have become county boundaries by accident, these counties having been formed by uniting smaller areas, not by dividing up the country between different tribes or kingdoms. This building up of counties by the union of agricultural communities appears to have taken place in the tenth century in connexion with the military system developed by Alfred and his successors. The **county-towns** were originally military fortresses on the main rivers, built at points where the enemy might cross. The county area was the area from which men were drawn to garrison the fort.

The counties north of the Mersey and Humber were defined later, after the Conquest ; those of Wales not until the sixteenth century ; but they are based upon much more ancient divisions. Thus, our county-system goes back in large measure a thousand years or more, and has persisted by a sort of geographical inertia in spite of immense changes in the distribution and occupation of the people. The **administrative counties** of to-day, however, are not really identical with the **ancient counties** whose names they bear. The boundaries have been frequently altered for convenience in administration ; Yorkshire and Lincolnshire have each been divided into three ; Sussex, Suffolk and Cambridgeshire into two ; and many large towns have been made quite independent of the county in which they lie. Yet in spite of much alteration of the ancient system, it remains with very little relation to modern industrial conditions.

PART II.

LESSON XLVI.

THE SOUTHERN UPLANDS OF SCOTLAND.

1. Make a table showing the rivers which reach the sea within the area of Fig. 77, the general direction of flow of each, the sea into which it flows, the chief towns on its course, and its approximate length.

2. Make a sketch-map of the Southern Uplands of Scotland, marking only the rivers Nith, Annan, Esk (and Liddel), Tweed (and Teviot) and Clyde.

Mark the four peaks shown on Fig. 77, with their altitudes, shade in the coalfields, and trace the following railway lines :

(1) North British Railway (East Coast route), from Newcastle (N.-o.-T.) through Morpeth (Mp.), East of Alnwick (Aw.), and Belford (Bf.) to Berwick-on-Tweed (B.-on-T.).

(2) N.B.R. (Waverley route), from Carlisle (C.) through Hawick (Hw.) and Galashiels (Ga.) to a watershed-pass just north of the limits of Fig. 77, a little east of 3° W. long., on its way to Edinburgh.

(3) Caledonian Railway, from Carlisle to west of Moffat (Mf.), to Carstairs (Cs.), on its way to Glasgow and Edinburgh.

(4) G.S.W.R., from Carlisle through Annan (An.), Dumfries (D.), Thornhill (Th.), Sanquhar (Sq.), Cumnock (Cu.), Kilmarnock (Km.) on its way to Glasgow.

These four railways are the four routes from England into Scotland. Arrange them in order, the one with the most level road first, and that with the most up-and-down road last.

3. Trace also on the same map the railway from Carlisle to Stranraer (St.) (for the north of Ireland), through Dumfries, Dalbeattie (Db.), and Castle Douglas (C.D.).

4. Measure the distance and direction of the following places from Carlisle—Newcastle, Berwick-on-Tweed, Hawick, Hamilton (H.), Ayr (A.) and Stranraer.

5. Represent by a series of graphs the statistics given below, in each case dividing the figures given by some constant which will give quotients of convenient amount for plotting on the space available. State in words the general relations which the curves indicate, and the exceptions to these general relations.

(1) Arrange the counties in order of the percentage of area cultivated, and plot curves representing the facts of columns 1, 2, 5 and 6.

(2) Arrange the counties in order of the number of sheep per 1000 acres, and plot curves representing columns 4, 6 and 7.

COUNTIES OF THE SOUTHERN UPLANDS.

	1	2	3	4	5	6	7	8	9	10
	Rainfall.	Percentage Cultivated of Total Area.	Percentage Arable of Total Area Cultivated.	Percentage of Arable devoted to		No. per 1000 Acres.			Percentage of Total Area.	
				Wheat and Barley.	Oats.	Cattle.	Sheep.	Population.	Woodland.	Waste.
Berwick.-	32	65.5	75	14	23	60	1085	105	4.9	24.3
Dumfries -	53	37.4	56	0	29	94	817	106	4.4	54.8
Kirkcudbright	50	33.3	52	0	28	87	682	68	3.4	58.7
Peebles -	39	22.4	70	1	22	32	891	67	5.1	70.5
Roxburgh -	40	42.9	62	10	25	44	1244	114	4.0	50.9
Selkirk -	41	17.2	56	1	31	21	1072	137	3.1	77.7
Wigtown -	40	49.8	76	0	27	168	376	105	2.7	36.7
All Scotland -	—	25.6	70	7	28	63	366	235	4.6	47.7

The Southern Uplands.—The geological map shows, on the north and west of the Carboniferous Limestone of the Pennine Axis, a belt of ancient rocks running across Great Britain and projecting south-westwards towards Ireland, where its continuation can be traced into the heart of that island. The broad Irish Sea contracts in crossing it into the narrow **North Channel**. As in Wales and the Lake District, so here, these rocks (slatey and gritty in character) form an area of high ground, which stands as a barrier between England and the populous lowlands of Scotland. It is the existence of this high barrier, known as the **Southern Uplands**, that has preserved Scotland as a kingdom independent of England.

The Southern Uplands are a high plateau, in which a number of valleys are cut. The Luce Water, Cree, Dee, Nith, Annan and Liddel flow southward into the Irish Sea or Solway Firth; the Doon, Ayr and Clyde northwestwards to the Firth of Clyde; and the Tweed eastwards to the North Sea. The two deepest of these valleys, **Nithsdale** and **Tweeddale**, divide the uplands into three parts. West of Nithsdale lies the peninsula of **Galloway**, projecting towards Ireland; south of Tweeddale are the **Cheviot Hills**; between and to the north of these lies the main mass of the Southern Uplands, ending on the north in the Moorfoot and Lammermuir hills. Both the Nith and a tributary of the Tweed, the Lyne, rise on the north side of the Southern Uplands, otherwise the Uplands form a continuous watershed from sea to sea.

The easiest way to get from England to Scotland is to avoid the upland barrier by keeping close to the coast. As the peninsula of Galloway makes the west coast too roundabout a route, it is by the east coast that communication between the two kingdoms was principally maintained before railways were made across the uplands. When the English first settled in this part of Great Britain it was along the east coast, and the Kingdom of Northumbria originally extended from the Humber to the Forth. Edinburgh, the capital of Scotland, takes its name from Edwin, King of Northumbria. But when the Kingdom of Scotland was founded in the lowlands, the river Tweed came to be the frontier near the east coast, the Cheviot water-

shed was the natural boundary inland, while on the west the Solway Firth and its inland continuation, the river Liddel, formed a suitable frontier.

Wool.—Like the uplands of Wales, those of South Scotland afford grass for large quantities of sheep, and the principal industry of the towns in Tweeddale is the weaving of cloth. **Hawick** and **Galashiels** are the chief towns of this industry. Agriculture is confined to the dales and the strip of lowland bordering both coasts. The other towns than those named are ordinary agricultural market-towns. **Dumfries**, at the lowest bridge-point across the Nith, is the most important. The uplands themselves are very thinly populated.

Railways.—The railways of the Southern Uplands have been made not so much for the benefit of their inhabitants as to provide communication between the populous districts north and south of them. The easiest route, as already pointed out, is along the east coast, the lowland border of which gets narrower northwards from the mouth of the Tyne to that of the Coquet. Hence to the mouth of the Tweed at Berwick an alternative route is furnished by the valleys of the Aln and Till, which are roughly parallel to the coast. North of Berwick the uplands come down close to the sea, and the railway has generally to run quite close to the shore, but near St. Abb's Head finds it easier to bend inland along small valleys that meet in a fairly low pass. The English part of this East Coast railway is part of the **North Eastern** system ; the Scottish part belongs to the **North British**.

Three other railways take much more difficult routes across the uplands themselves, all starting from Carlisle.

The **Glasgow and South-Western** follows the north coast of Solway Firth to Dumfries, then mounts Nithsdale to a pass at 700 feet above the sea, and thence runs down the Ayr valley towards the west coast.

The **Caledonian** mounts Annandale to near Moffat and climbs by an eight-mile long incline at 1 in 80 to the Beattock pass (1000 feet), whence there is an easy run down Clydesdale.

The **North British** has the most difficult route of all, as it crosses the Uplands where they are cut into two by Tweeddale,

and consequently must cross two watersheds instead of one. The first crossing is from Liddesdale to a tributary of Teviotdale by the Riccarton tunnel at nearly 1000 feet; the second at Heriot summit (900 feet) on a pass at the head of the Gala water between the Moorfoot and Lammermuir hills. As a compensation for its greater difficulty this route has the important woollen-manufacturing towns of Hawick and Gala-shiels on its course. It is known as the "Waverley Route" because it passes through the district where Sir Walter Scott lived and wrote his Waverley novels.

The westward projection of the land in Galloway affords a good route to the north of Ireland, with the shortest sea-passage to that island. A railway branches off from the Glasgow and South-Western at Dumfries and runs to the port of **Stranraer**, on Loch Ryan, whence steamers cross to Larne.



FIG. 78.—THE MIDLAND VALLEY OF SCOTLAND.

The two thick lines are the boundary-faults of the Highlands and Southern Uplands. The area between them, marked "Lowlands," is the Midland Valley.

LESSON XLVII.

THE MIDLAND VALLEY OF SCOTLAND.

1. On Fig. 78 measure the average breadth of the Midland Valley of Scotland (measuring at right angles to the bounding lines separating it from the Highlands and Southern Uplands).

2. Measure the approximate area in square miles of the four chief coalfields.

3. Measure and state in tabular form the direction and distance of the following places from Glasgow and from Edinburgh—Edinburgh, St. Andrews, Dunfermline, Perth, Stirling, Greenock and Kilmarnock.

4. Shade an outline county map of Scotland according to the density of population—less than 100 to 1000 acres, blank; between 100 and 250, lightly shaded; between 250 and 1000, darker shading; over 1000, black.

From a study of the map thus shaded, write down a statement of the distribution of population between the three natural divisions of Scotland marked on Fig. 78 as Highlands, Lowlands and Southern Uplands respectively.

DENSITIES OF POPULATION IN SCOTLAND, 1901.

County.	Population per 1000 Acres.	County.	Population per 1000 Acres.	County.	Population per 1000 Acres.
Aberdeen -	241	Fife - -	677	Orkney - -	119
Argyll - -	37	Forfar - -	508	Peebles - -	67
Ayr - - -	351	Haddington -	226	Perth - - -	77
Banff - - -	153	Inverness -	30	Renfrew - -	1758
Berwick - -	105	Kincardine -	167	Ross and Cromarty	39
Bute - - -	134	Kinross - -	134	Roxburgh - -	114
Caithness -	77	Kirkcudbright	68	Selkirk - - -	137
Clackmannan -	915	Lanark - - -	2379	Shetland - -	80
Dumbarton -	725	Linlithgow -	853	Stirling - - -	492
Dumfries - -	106	Midlothian -	2090	Sutherland - -	17
Elgin - - -	147	Nairn - - -	89	Wigtown - - -	105

5. Represent by percentage diagrams the statistics given below.

OCCUPATIONS IN SOUTHERN SCOTLAND, 1901.

Counties.	Percentage of Occupied Persons engaged in				
	Agriculture.	Fishery.	Making Metals and Machinery.	Textile Industry.	Mine and Quarries.
Roxburgh, Dumfries, Kirkcudbright and Wigtown	6	29	3	10	2
Linlithgow, Edinburgh, Haddington, Berwick, Peebles, and Selkirk	10	7	5	4	6
Renfrew, Ayr, and Lanark	9	3	17	9	9
England and Wales for comparison	8	—	9	8	6

The Midland Valley.—There is no region in the British Isles more sharply defined on the geological map than the Midland Valley of Scotland. From Stonehaven on the east coast to Helensburgh on the estuary of the Clyde an almost straight line separates it from the Highlands; and from the Southern Uplands it is marked off by an almost equally straight line from Dunbar to Girvan. These are great **fault-lines**, or lines of dislocation in the earth's crust, like, but much longer than, that separating the Leicestershire coalfield from Charnwood Forest (pp. 103, 105). In the case of the Highland boundary fault there is clear evidence that the idea of a great dislocation is no mere matter of imagination, for the town of Comrie, situated just on the fault, is more subject to **earthquakes** than any other place in the British Isles. The area between these two great faults is occupied by rocks of the Old Red Sandstone and Carboniferous systems, while quite different rocks lie on either side.

Physically also the Midland Valley is well defined. It must

not be supposed, however, that it is a low plain. Its average altitude is much less than that of the Highlands and Southern Uplands, but it includes within its area high hill-ranges, some attaining to over 2000 feet above the sea, that is to say but little less than the highest parts of the Southern Uplands. Where such hills come close to the border of the Midland Valley, as do the **Pentland Hills**, the physical distinction between the two areas is much slighter than the geological.

The distinction from the Highlands, on the other hand, is sharp and clear, and for this reason the Midland Valley and Southern Uplands are commonly united under the term **Lowlands**, in contrast to the **Highlands**.

Perhaps more striking than the difference of altitude is the difference in coast-line between the Midland valley and the lands to the north and south. Scotland is here much narrower than elsewhere, even if we take no account of the long estuaries of the Tay, Forth and Clyde that extend so far inland.

Volcanic rocks.—There is in fact nothing in the Lowlands like the great English plains, because there are no rock-formations like the London and Oxford Clays or the New Red Marl. The nearest comparison to be made with England is perhaps with the lowlands of the Welsh border, where also Old Red Sandstone is the predominant geological system. There is, however, an important feature in the Old Red and Carboniferous rocks of Scotland not found in England; at the time when the sandstones, limestones and coal-seams were being formed as deposits on the bottom of a great lake, or an arm of the sea, or a forested swamp, there were great volcanic eruptions and immense sheets of **lava** were poured out from time to time. These lavas, being harder than the rocks among which they occur, now stand out in long hill-ranges with steep escarpments, like, but more prominent than, the escarpments of the Chalk and Oolites in England. These form the main hill-ranges of the Midland Valley—**Campsie Fells**, the **Ochils**, the **Sidlaws** and the **Pentlands**.

Communications.—The hill-ranges and estuaries together so divide up the Midland valley that communication between

one part and another has none of the easiness found on the Great Red Plain or Oxford Clay vale of England; and the comparatively narrow connexions between one lowland area and another come to have great importance. In ancient times this importance was a strategic one, as they determined the routes of invaders and the sites of fortresses and battles. Now it is a commercial importance, determining railway routes and junctions.

Strategic points.—At the foot of the Highlands, from Crieff to Montrose, there stretches a long belt of lowland, the broadest part of which is known as **Strathmore** (the great vale). This may be compared to such a lowland as the Oxford Clay vale in England, and like that it is bounded on the south-east by an escarpment, that of the Ochils and Sidlaws. Like the English vale it does not lie within one river-basin, though most of it comes within that of the Tay. A narrower continuation of this lowland to the south-west is occupied by part of the river Forth, and extends to the Clyde at Dumbarton, across a watershed less than 100 feet above the sea, having the Campsie Fells and Kilpatrick Hills as its bounding escarpment on the south-east. These two rivers, the Forth and the Tay, and their many tributaries, rise in the Highlands, flow out of them generally in a south-eastern direction, then turn north-east or south-west along the lowland, and there unite into the two main streams which again flow south-east, their course cutting up the lava-escarpment into the three main blocks—Campsie Fells, the Ochils and the Sidlaws. Where the valleys thus cross the lava-belt they are narrow, and here stand the strategic and railway centres, **Stirling** and **Perth**. After this part of their course, both rivers turn east to their broad estuaries. From the head of the Forth estuary, there runs south-westwards, on the south side of Campsie Fells, a very narrow strip of very low ground: this is crossed by the watershed between the Forth and the Clyde, and where it comes down to the Clyde stands **Glasgow**. In the other direction this strip is joined to the strip along the east coast, already described as the easiest railway route from England to the Lowlands, by the lowland bordering

the south side of the Firth of Forth. Where the Pentland Hills run down to the coast and this lowland is narrowest, stands **Edinburgh**.

Edinburgh, Glasgow, Stirling and Perth are the four keys to the geography of the Scottish Lowlands.

Coalfields.—The Scottish coalfields are geological basins, or parts of basins, with Coal Measures in the centre and Lower Carboniferous rocks rising up at the margin; but in Scotland the best coal-seams do not occur in the Coal Measures themselves, as in England, but in the Lower Carboniferous rocks. Consequently, the area of each coalfield is greater than the area shown as Coal Measures on the geological map, as may be seen by comparing that map with Fig. 78. The coal-seams occurring near the margin of the coalfields are known as **Edge Coals**. Among them, as in other coalfields, are found the stumps of the trees that grew among the vegetation which went to form coal (Fig. 79).

The Scottish coalfields all lie within the Lowlands, with one small exception (now practically exhausted) at Brora on the east coast of the Highlands. Two small coalfields lie within the Southern Uplands, one in the upper part of the Nith valley, the other in Dumfriesshire near the English border. The four most important lie within the Midland Valley, and are from south-west to north-east.

(1) The **Ayrshire coalfield**, on the west coast and in the valleys of the Ayr and Irvine.

(2) The **Lanarkshire coalfield**, the largest, extending from the Clyde, south-east of Glasgow, to the head of the Firth of Forth.

(3) The **Midlothian coalfield**.

(4) The **Dunfermline or Clackmannan and Fife coalfield**, which is a double basin, its eastern and western portions being probably continuous under the Firth of Forth with the Midlothian and Lanarkshire coalfields respectively.

As elsewhere, so in the Scottish Lowlands, it is on the coalfields that population is thickest and manufactures concentrated. Besides coal itself, oil-shale is an important mineral

product. This is a dark rock splitting into thin layers, from which, by distillation, oil, wax, and ammonium sulphate are obtained. Iron-ore was once an important product, though it



FIG. 79.—REMAINS OF A FOSSIL FOREST OF THE COAL MEASURE PERIOD, VICTORIA PARK, PARTICK, GLASGOW.

From a photograph by Mr. J. R. Stewart, reproduced by kind permission of Prof. W. W. Watts, F.R.S., secretary of the Geological Photographs Committee of the British Association.

is now in large part exhausted; but the iron-smelting based upon it continues, through industrial inertia, as an important industry at Kilmarnock in the Ayrshire coalfield and Motherwell and Coatbridge in that of Lanarkshire.

LESSON XLVIII.

THE AYRSHIRE COALFIELD AND THE CLYDE.

1. Make a tracing of Fig. 80, marking only the principal rivers and coast-line, and shading the areas rising above 500 feet. Insert on this by comparison with Fig. 78, the



FIG. 80.—THE CLYDE BASIN.

Contour-lines at 500, 1000 and 2000 feet above sea-level.

boundary-line (fault) of the Highlands, and the outline of the coalfields.

Do the coalfields occur in the higher or lower portions of the Midland Valley? What physical difference is there in the country on the two sides of the Highland boundary-fault?

2. Measure the area of the Clyde basin; and make a list of the chief passes across the watershed, distinguishing those below 500 feet altitude from those above, and stating against each the tributary (if any) of the Clyde at the head of which it lies, the river-basin into which it leads, and the railway (if any) by which it is occupied.

3. Make a sketch-map of the Lanarkshire coalfield and mark by a dot the site of each furnace in blast in 1906.

NUMBER OF FURNACES IN BLAST IN LANARKSHIRE, 1906.

Coatbridge (Ct.)	-	-	32		Shotts ¹	-	-	-	-	4
Glasgow (G.)	-	-	10		Newmains ¹	-	-	-	-	8
Wishaw (W.)	-	-	4		Carron, near Falkirk (F.)	-	-	-	-	4

4. Describe and illustrate by a sketch-map the course of the following railways:

(1) Caledonian,

(a) from Carstairs (Cs.) to Carlisle (Cl.), Wishaw (W.), Motherwell (on the opposite side of the Clyde to Hamilton, H.), Glasgow and Greenock (Gr.).

(b) from Carstairs to Edinburgh (as far as the map shows).

(c) from Motherwell to Coatbridge (Ct.) and Stirling (St.).

(2) Caledonian or North British, from Glasgow to Stirling.

(3) Glasgow and South-Western,

(a) from Glasgow to Kilmarnock (Km.), Cumnock (Cu.) and Nithsdale (for Carlisle).

(b) from Glasgow through Paisley (Py.), Johnstone (J.), Dalry (Dy.), Irvine (I.), Ayr (A.), and Maybole (Mb.) towards Stranraer.

(4) North British, from Stirling to Balloch (at the southern end of Loch Lomond).

(5) West Highland, from Glasgow through Dumbarton (Db.) and Helensburgh (Hb.), to the northern margin of the map.

¹ Shotts lies higher up the same tributary valley as Wishaw, and Newmains still higher, near the watershed.

5. On an outline county map of Scotland place on each county a dot for every 10,000 tons (or fraction thereof) that it produces.

IRON ORE RAISED IN SCOTLAND, 1906.

County.	Quantity.	County.	Quantity.
	1000 tons		1000 tons
Ayr - - -	319	Linlithgow - -	53
Dumbarton - -	3	Renfrew - -	125
Edinburgh - -	43	Stirling - -	32
Fife - - -	23		
Lanark - -	277	Total - -	875

Quantity of iron ore imported into Scotland - -	2,044,000 tons.
" " " United Kingdom	7,823,000 "
" " raised in "	15,500,000 "

6. Make a series of percentage diagrams to show (a) the proportions of home-raised and imported iron-ore for Scotland, (b) the proportion of Scotch home-raised ore to the total of the United Kingdom, (c) the proportion received by Scotland of the total iron-ore imported into the United Kingdom.

Ayrshire coalfield.—The rivers which flow to the west coast of the Lowlands of Scotland are—with the one exception of the Clyde—short and not navigable. The Stinchar and Girvan have their courses entirely within the area of the Southern Uplands, but the Doon, Ayr, Irvine and Garnock flow through the **Ayrshire Coalfield**.

Here are several busy ports: at Ardrossan, Troon and Ayr there are shipbuilding works; at Irvine, copper-smelting and engineering works; while a few miles inland is **Kilmarnock**, an engineering town, where locomotives and pumping machinery especially are made. At Kilwinning near the coast, and Dalmellington, Cumnock and other places inland there are many iron-furnaces. The coal and iron of this coalfield are sent very largely across the North Channel to the manufacturing town of Belfast, in Ireland.

The Clyde rises in the centre of the Southern Uplands, the upper part of its basin being wedged in between those of the

Nith and Annan. The first part of its course is therefore among bleak moorlands, but high up on the watershed (1400 feet) between it and the Nith is the little town of **Leadhills**, the loftiest town in the British Isles, which takes its name from the lead-mining there carried on. As the river reaches the boundary of the Southern Uplands, its valley widens out and the watershed between it and the Tweed basin sinks so low that in times of flood the two may be united. The little town of **Biggar** marks the position of this low pass.

The Clyde, hitherto flowing northwards, now turns north-west, and, after a series of waterfalls near the town of Lanark and a short course through fertile agricultural land, enters the great **Lanarkshire coalfield**—the busiest industrial district in Scotland. It differs from the great industrial districts of England by not showing the same amount of specialization: that is to say it does not confine itself to one principal industry as Lancashire does to cotton, Birmingham to metal-work and so on. This is the result of the comparative isolation of the Midland Valley, shut off more completely from other industrial areas by the broad upland barrier than any two English industrial areas are from one another. The damp climate makes cotton-spinning possible, but there are silk and woollen industries also, metal-works, chemical works, potteries, sugar-refineries and, on the Clyde estuary, the greatest **shipbuilding** industry in the world. The centre of all this busy region is the great city of **Glasgow**, which will be considered in the next lesson.

Iron-smelting.—Iron-ore was once an important product of the Lanarkshire coalfield, and though it is now nearly exhausted, the blast-furnaces that once smelted it are still at work. While some of these are situated in the outskirts of Glasgow itself, the chief iron-smelting is carried on in tributary valleys to the Clyde, along which the railway-lines find their way towards the Forth and Edinburgh. Along the South Calder Water lie the towns of **Motherwell** and **Wishaw**, and the smaller places, Newmains and Shotts; on the North Calder Water, the

large town of Coatbridge; and across the watershed by the easiest of all passages, near the Forth itself are the Carron ironworks. Originally located at these places for the sake of the valuable local ore, they have remained there by industrial inertia although now largely dependent on foreign ore. Hamilton is a coal-mining town.

LESSON XLIX. GLASGOW AND THE CLYDE.

1. Examine Fig. 81. What is the compass-bearing of the sides of the map? What is the scale? What area does the map represent? Make a mask to represent this area on the scale of 25 miles to an inch and fit it on to Fig 80.

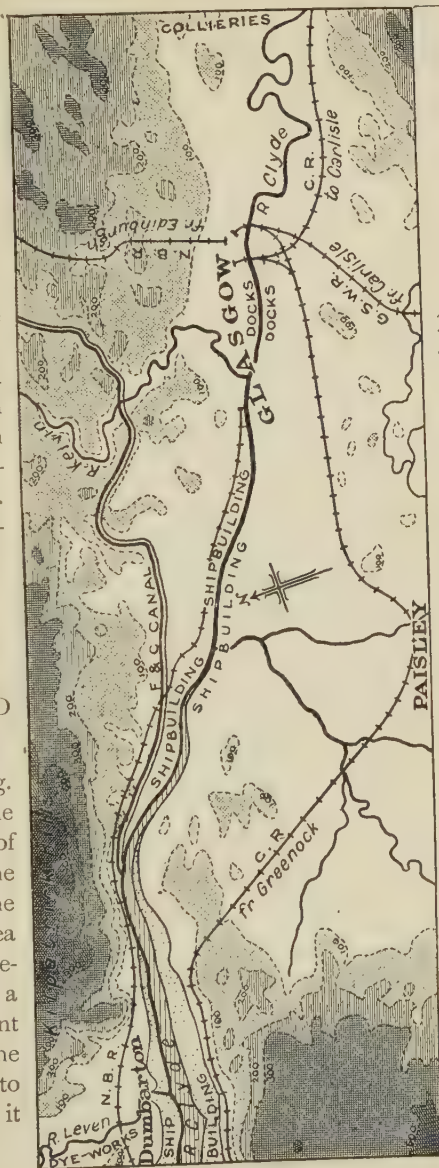


FIG. 81.—THE CLYDE NEAR GLASGOW. (Scale—3 miles to an inch.)
Contour-lines at intervals of 100 feet up to 300 feet above sea-level; above that, at intervals of 300 feet.

2. Find the approximate distance and direction of Dumbarton and of Paisley from Glasgow (measuring from the middle of the printed name in each case). What is the width of the Clyde at Dumbarton (*a*) at low water, (*b*) at high water?
3. Measure the *average* gradient for a convenient distance from the Clyde
 - (*a*) On the north side where the rise is most rapid ;
 - (*b*) In the direction of the North British railway to Edinburgh ;
 - (*c*) On the south side at the western edge of the map (measure this in two sections, below and above 300 feet) ;
 - (*d*) Along the line of the arrow indicating the N. direction ;
 - (*e*) Along the course of the river Kelvin ;
 - (*f*) Along the course of the Forth and Clyde canal.
4. Assuming that the canal-level rises 10 feet at each lock, and that the Kelvin valley is crossed by means of an aqueduct, about how many locks should there be on the canal within the map? Make a sketch-map of the course of the canal (showing the contour-lines) and divide it into sections such that you can state about each that it contains a certain number of locks, or no locks.
5. Represent the following statistics graphically by a series of parallel vertical lines on a horizontal base, their height being proportional to the figures of the respective countries.

SHIP-BUILDING IN 1907.

District or Country.	Number of Vessels built.	Tons	Horse- Power.
Clyde - - -	526	1000 620	1000 669
Tyne - - -	148	337	326
Wear - - -	90	295	212
Tees and Hartlepoons } - -	83	240	118
United States - -	177	456	305
Germany - - -	507	321	279

6. Make percentage diagrams from the following table, to show the ratio of the chief imports and exports of Glasgow to the totals.

GLASGOW—CHIEF IMPORTS AND EXPORTS, 1907.

IMPORTS.	Value.	EXPORTS.	Value.
	£1000		£1000
Corn, flour, etc. - - -	4,646	Cotton goods (including yarn) - - -	5,346
Timber - - -	1,236	Iron and steel manufactures - - -	5,276
Meat - - -	1,198	Machinery - - -	4,936
Iron ore - - -	1,093	Ships and boats, new (not registered as British) -	2,176
Cattle - - -	598	Linen manufactures (including yarn) - -	1,964
		Spirits - - -	1,916
		Jute goods (including yarn)	888
		Chemicals - - -	780
All imports - - -	15,205	All exports - - -	30,900

7. Illustrate the trade of Greenock by percentage diagrams.

CHIEF IMPORTS AND EXPORTS OF GREENOCK, 1907.

IMPORTS.	Value.	EXPORTS.	Value.
	£1000		£1000
Unrefined sugar - - -	1,116	Ships and boats, new (not registered as British) -	767
All other imports - - -	487	All other exports - - -	36

Glasgow is not only the largest city in Scotland, but the second city in the British Isles. This important position it owes to a number of causes. First comes its site in relation to routes of communication: it stands at the lowest point where the Clyde could easily be bridged (though, until modern times, it could be forded at low tide as far as twelve miles below Glasgow); at a point whence there is an easy route to the Firth of Forth, and another into the Highlands (by Loch

Lomond). It was therefore in early times an important strategic point and market town, and its ancient University and Cathedral indicate this early importance.

Secondly, the Clyde is the only long river opening on the west coast of Scotland; consequently for trade between Scotland and **Ireland**, and later between Scotland and **America** the Clyde had a practical monopoly, and Glasgow, being already the most important place on the Clyde, took the greatest share of the trade that resulted from the discovery and colonization of America.

Thirdly, the Clyde is the natural outlet for the trade of the great coalfield of Lanarkshire.

Like other ports some distance up a river, Glasgow would have been unable to keep its trade with the great increase in size of modern trading vessels if it had not taken measures to improve itself as a port. The Clyde has been artificially deepened until large ocean liners can now steam up to the place where the river could once be forded. At Glasgow itself the river was bridged: it was therefore the farthest point inland to which the deepening of the channel could be extended—a fact which explains its present commercial superiority over other places on the Clyde.

Ship-building.—Below Glasgow, a succession of ship-building towns extends for twenty miles—Partick, Clydebank, Dalmuir, Kilpatrick, Bowling and Dumbarton on the right bank; Govan, Renfrew, Port-Glasgow and Greenock on the left. The building of iron ships and the fitting, both of these and of wooden ships built elsewhere, with steam-engines and other machinery, is the great business of all these places. But some of them have other titles to fame. Of these, **Dumbarton**, at the mouth of the Leven, which leads by Loch Lomond into the heart of the Western Highlands, was the ancient capital of the Kingdom of Strathclyde.

Greenock refines sugar imported from the West Indies. **Paisley** stands a few miles south of the Clyde: it is best known as a cotton-spinning town, the manufacture of cotton thread being its chief industry; but there are also starch- and corn-

flour-works, and large engineering works, where particularly hydraulic and electrical machinery and cotton-thread machines are made.

The Clyde estuary.—As the Clyde widens out below Glasgow, there is seen on either bank a well-marked natural terrace about 25 feet above sea-level. These are **raised beaches**, formed by wave-action on the shore at a time when the land lay 25 feet lower relatively to the sea-level than now. Such raised beaches are found at intervals all round the coasts of Scotland, and form useful sites for the easy construction of roads and railways, as in the case of the railway from Glasgow to Dumbarton.

Beyond Greenock, the Estuary of the Clyde widens out into the **Firth of Clyde**, which turns southwards between the mainland and the peninsulas of Cowall and Kintyre and the islands of Bute and Arran. It is now the scene of pleasure as well as business, especially during the summer when passenger-steamers run from here not only across the firth to Rothesay and other holiday resorts, but to all parts of the west coast of the Highlands. At Gourock, Wemyss Bay and Ardrossan, railways from Glasgow carry tourists direct to the piers and save them the long boat journey down the Clyde.

From Ardrossan southwards the Firth of Clyde has the Ayrshire coalfield on its eastern shore. On the western side lies the large and hilly island of **Arran**, its highest summit, Goat Fell, nearly 3000 feet above the sea. On the other side of this island, across the narrow but deep Kilbrennan Sound, is the peninsula of **Kintyre**—a portion of the Highlands stretching to within 14 miles of Ireland. From the southern end of this peninsula a submarine ridge runs eastwards to Girvan, separating the deeper waters of the Firth of Clyde from those of the North Channel. At one point this ridge rises up above sea-level more than a thousand feet into the steep islet, **Ailsa Craig**.

LESSON L.

EDINBURGH AND THE FORTH.

1. Examine Fig. 82. Measure the area of the Forth basin
 - (a) In the narrower sense, as marked on the map,
 - (b) In the broader sense, including the basins of all streams flowing into the Firth of Forth.



FIG. 82.—THE FORTH BASIN.

Contour-lines at 500, 1000 and 2000 feet above sea-level.

2. Make a sketch-map showing the alternate belts of low and high ground crossing the lowlands from W.S.W. to E.N.E., and the relation of the Forth to these.

Refer to the geological map, and write on each belt the name of the rocks that compose it.

3. Describe and illustrate by a sketch-map the course of the following railways :

(1) North British, from Glasgow (G.) to Falkirk (F.), Linlithgow (LL.), Edinburgh (E.), Prestonpans (Pp.) and towards Berwick and Newcastle-on-Tyne.

(2) Caledonian, from Glasgow through Stirling (St.) to Perth (P.).

(3) N.B.R., from Edinburgh through Queensferry (Q.), Dunfermline (D.) and Milnathort (Mn.) to Perth.

4. Complete your description (Lesson XLVI.) of the North British line from Carlisle to Edinburgh (Waverley route).

5. On an outline county map of Scotland shade darkly the counties in the table given below. In what basin do the majority of them lie, wholly or partly? Shade also more lightly the counties with over 25 per cent. of their area cultivated, *vis.* Aberdeen, Ayr, Banff, Caithness, Clackmannan, Dumbarton, Dumfries, Elgin, Forfar, Kincardine, Kirkcudbright, Lanark, Orkney, Roxburgh, Stirling and Wigtown. Compare this map with that already shaded for population, and write out a statement of the results of your comparison.

SCOTTISH COUNTIES HAVING MORE THAN HALF THEIR
AREA CULTIVATED.

County.	1 Rainfall.	2 Percentage Cultivated of Total Area.	3 Percentage Arable of Total Cultivated.	4 Percentage of Arable given to		6 Number per 1000 Acres.	
				Wheat and Barley.	Oats.	Cattle.	Sheep.
Berwick - - -	32	65.5	75	14	23	60	1085
Haddington - - -	29	65.4	82	22	19	57	732
Midlothian (Edinburgh)	34	54.2	66	12	26	86	736
Linlithgow - - -	33	75.7	58	12	29	158	294
Kinross - - -	42	67.4	63	2	28	133	639
Fife - - -	34	78.8	70	18	22	153	333
Renfrew - - -	45	58.9	48	3	24	167	253
All Scotland - - -	—	25.6	70	7	28	63	366

6. Divide the counties in the above table into three groups:

(a) Those which grow about as much wheat and barley as oats.

(b) Those that grow about half as much wheat and barley as oats.

(c) Those that grow very little wheat and barley.

What is the range of rainfall in each group? Do the facts agree with what you have learned as to the cultivation of wheat and barley and oats respectively, in England?

7. Arranging the counties in the table on p. 259 in order of the number of cattle on a given area, make a graph to illustrate the figures in columns 1, 3, 6 and 7. State in words the general relations which the graphs show, and the exceptions to the general rules.

8. Make percentage circles (of proportionate size) to represent the imports and exports of Leith, indicating separately only those items which amount to 10 per cent. of the total in each case.

CHIEF IMPORTS AND EXPORTS OF LEITH, 1907.

IMPORTS.	Value.	EXPORTS.	Value.
	£1000		£1000
Corn and flour - -	2,881	Machinery - - -	941
Butter and cheese -	2,750	Coal - - - -	696
Sugar, refined - -	1,376	Cotton goods - -	627
„ unrefined - -	196	Herrings - - -	602
Eggs - - - -	1,076	Linen yarn and goods -	539
Flax - - - -	369	Ammonium sulphate -	517
Woollen yarn and goods	369	Iron, and iron and steel	
Seeds - - - -	364	manufactures - -	311
Timber - - - -	341	Corn, etc. - - -	239
Linen yarn and goods -	299	Rubber goods - -	225
Paper - - - -	210	All other exports - -	2,346
All other imports - -	3,645		

The Forth.—The river **Forth** and its higher tributaries have their source in that part of the southernmost Highlands that rises like a wall on the eastern side of Loch Lomond, and attains its greatest height in **Ben Lomond** (3192 feet). Near the head of one of these tributaries, the Teith, lies the beautiful **Loch Katrine**, from which Glasgow obtains its water through a long tunnel. Loch Katrine stands 360 feet above the sea, and a low pass across the Ben Lomond mountains leads in four miles to Loch Lomond, from which the Leven flows to the Clyde at Dumbarton; while on the other side of Loch Lomond a still lower and shorter passage leads to the head of Loch Long, an inlet of the sea. Thus, the Forth basin nearly cuts Scotland, across from west to east.

Stirling.—The Forth itself soon emerges from the Highlands into the red-sandstone of **Strathmore**. Here a pass low enough for a railway connects it to the Leven and Clyde. It receives the Teith from Loch Katrine, and the Allan Water (which drains the next section of Strathmore and so affords a route towards the Tay) as it turns south between the Ochil Hills and the Campsie Fells range. Here a high volcanic rock overlooks the river and afforded a fine site for **Stirling Castle** to guard one of the most important routes from Highlands to Lowlands, at the lowest point where a road-bridge could be thrown across the Forth. Close at hand is **Bannockburn**, where the battle was fought that settled the independence of Scotland in 1314. Like so many other places that were of strategic importance in warlike times, Stirling is now important as a railway junction. Lines from both sides of the Firth of Forth meet here, to diverge again along the upper Forth, Teith and Allan Water respectively.

Firth of Forth.—The Forth now enters the area of Coal Measures, and here a low depression, occupied by two railways and the Forth and Clyde canal, affords an easy route to the Clyde. The river widens to its estuary, and the important port of **Grangemouth** serves as the eastward outlet of the trade of the great coalfield. Alloa and Borrowstoness (or Bo'ness) are smaller ports chiefly engaged in coal-shipping. Below Grangemouth the coalfield is followed by the oil-shale district, from which much oil and ammonium sulphate are obtained.

The inlet of the Firth of Forth cuts across half the breadth of Scotland and forms an interruption to direct land-communication between many important places. There are consequently a number of points where ferries have long been established. One of these, Queensferry, is at a point where the estuary contracts very much in width before it finally widens out into the broad firth. This convenient narrowing has now been taken advantage of for the construction of a railway-bridge, the **Forth Bridge**, more than a mile long, which enables trains to travel from Edinburgh to Perth and Dundee without having, as formerly, to go round by Stirling. Close to the north side

of the bridge is **Rosyth**, where are now being constructed docks for battleships of the largest size, which, when completed, will enable the Navy to use the Forth as a base for North Sea operations.

The oil-shales belong to the Lower Carboniferous rocks that rise up at the edge of the great Lanarkshire coalfield. Between this and the smaller and more steep-sided coal-basin of Midlothian there rises up a ridge of Old Red Sandstone and volcanic rocks, forming the **Pentland Hills**, and continuing as a series of steep hills to the Firth of Forth near Leith. Twelve centuries ago, Edwin, King of Northumbria, took advantage of one of these steep hills to build a fortress, which, by its position, could command the narrow strip of low ground along which any army marching from Dumbarton and the Clyde towards Northumbria must needs pass. The fortress was called Edwin's borough, and around it the city of **Edinburgh** grew up. It passed in time with the surrounding country from the Kingdom of Northumbria to that of Scotland, and eventually became the capital of the latter, which it still is. As the seat of the law courts, and the centre of the Civil Service of Scotland, and having an ancient University, Edinburgh is the political and intellectual capital of Scotland, and the printing and publishing of books is one of its chief industries, though of late years London competition has weakened it. Its other chief industries are milling, brewing and distilling; and it is a great railway centre, and has a large cattle-market. **Leith**, which is almost continuous with Edinburgh, is its port. It imports grain, flour, sugar, esparto (for paper-making), wood and guano (for the agricultural districts around); and exports pig-iron (from the Lanarkshire furnaces), ale, ammonia (from the oil-shale works) and coal.

The low ground between the south coast of the Firth of Forth and the Pentland and Lammermuir Hills constitutes the district of **Lothian** or the Lothians (East, Mid and West Lothian). Except where coal and oil-shale are mined, it is a rich and well-cultivated agricultural district, escaping the heavy rainfall of districts farther west.

LESSON LI.

THE NORTHERN LOWLANDS.

1. From Fig. 83 make a list of the chief right-bank and left-bank tributaries of the Tay.



FIG. 83.—THE TAY BASIN.

Contour-lines at 500, 1000 and 2000 feet above sea-level.

2. Make a sketch-map showing the relation of the Tay to the belts of high and low ground crossing its basin. Call these the *Highlands*, *Strathmore*, and the *Ochil-Sidlaw range*, and write upon each the character of the geological formations of which it is composed.

3. Measure the area of the Tay basin, (a) not including, and (b) including the area draining into the Firth of Tay.

4. Measure the length and breadth of the four chief lakes (lochs) on the course of the Tay and its tributaries. In which of the natural divisions of the basin do they all lie?

5. Describe and illustrate by a sketch-map the course of the following railways :

(1) Caledonian, from Stirling (outside the map), through Auchterarder (Au.), Perth (P.), Coupar-Angus (C.A.) and Forfar (Ff.) towards Aberdeen.

(2) Callander and Oban Railway, from Stirling to the head of Loch Earn, near the western end of Loch Tay and westwards towards Oban.

(3) Highland Railway, from Perth, through Dunkeld (Dn.), Pitlochry (Pt.) and Blair Atholl (B.A.) to the Pass of Drumochter.

6. Illustrate the imports and exports of Dundee by percentage circles. Comment upon the fact that the exports of jute and linen goods are far less in value than the corresponding import of raw materials.

CHIEF IMPORTS AND EXPORTS OF DUNDEE, 1907.

IMPORTS.	Value.	EXPORTS.	Value.
	£1000		£1000
Jute - - - -	3,990	Jute yarn and goods -	492
Flax - - - -	671	Bags, sacks and cordage	199
Sugar, refined - -	199	Linen yarn and goods -	80
Timber - - - -	153	All other goods - -	163
All other goods - -	694		

Fife.—The peninsula of **Fife**, lying between the Firths of Forth and Tay, contains two rather broken ridges of volcanic rock, one continuing the Ochil Hills along the south border of the Firth of Tay, the other parallel to it along the centre of the peninsula. Alternating with these ridges are two lowlands—the northern one, called the **Howe of Fife**, a very fertile area of Old Red Sandstone; the other, the Dunfermline coalfield and adjacent region north of the Firth of Forth.

The western ports of the coalfield have already been mentioned (p. 261). The eastern part ships its coal at **Methil** (close to Leven, Lv., Fig. 83). Of greater importance are the two manufacturing towns—**Dunfermline**, where **linen-weaving** is carried on, and **Kirkcaldy**, where **oil-cloth** is made. The raw materials of these industries, **flax** and **jute** respectively, are

obtained from western Europe and India, so that it is as natural for these industries to be placed on the east coast as for cotton-spinning to be near the west coast. **Linoleum**, however, which is also made at Kirkcaldy, differs from oilcloth in that its raw material is not jute but **cork**, imported from Spain.

The Eden valley is a rich agricultural area, with the market and county-town of Cupar in its centre, and the ancient university town of **St. Andrews** near the river-mouth.

The Fife peninsula is crossed by railways, chief among which are the direct lines from the Forth Bridge to Perth and Dundee. The former crosses the Ochils by the narrow gorge of Glenfarg. The latter follows the depression between the Lomond and Fife hills and continues along the Eden valley to its mouth, and then north to the Tay, which it crosses by a bridge even longer than the Forth Bridge.

The Tay rises like the Forth in the Highlands, not far from the west coast, but the passes at its head are not so easy nor do they lead to any important place. Its northernmost tributary, the Garry, has however at its head the **pass of Drumochter**, the lowest point on the main east-and-west Highland watershed, and here the Highland railway crosses it on its way to Inverness and the far north. The Tay emerges into the lowlands at Dunkeld and with its tributaries, Isla on the left bank and Almond on the right, occupies the main part of Strathmore. It then turns south to pass between the Ochils and Sidlaws, just as the Forth does between the Ochils and Campsie Fells; and **Perth** occupies on the Tay very much the position that Stirling does on the Forth. Owing to its great strategic importance, Perth (or to be exact, Scone, near it) was long the capital of the kingdom of Scotland. To-day it is a great railway-junction, lines from Stirling and Edinburgh entering it from the south, and others diverging eastwards to Dundee, westwards to Crieff, northwards to Inverness and northeastwards to Aberdeen. As in other towns on the Forth and Tay, linen-spinning and jute-weaving are carried on at Perth, and carpets are made; but above other towns Perth has specialized in the **dyeing** and **cleaning** of these and other textiles.

Below Perth the Tay soon widens out into its estuary, and along its northern shore there is a broad strip of alluvial ground, the **Carse of Gowrie**, well suited for fruit-growing. As in the case of the Forth, the Firth of Tay narrows before its mouth, and here is the **Tay bridge**, and on the north side the town of **Dundee**. At one time Dundee was the centre of the **whale-fishing** industry, but this is now practically extinct. The staple industry is jute-weaving. **Jute** is a vegetable fibre imported from India, and is specially suitable for sacking and similar coarsely woven fabrics. Flaxen and hempen yarns are also spun, and textile machinery is manufactured. Another important industry is the making of preserves (partly dependent on the Carse of Gowrie fruit) and confectionery.

LESSON LII.

THE EASTERN HIGHLANDS.

1. By tracing the necessary outlines on squared tracing-paper, measure the following areas on Fig. 84 :

(a) Total land area lying to the east of the chain of lakes and streams in Glen More ; and the portions of this area

(b) Below 500 feet,

(c) Between 500 and 2000 feet,

(d) Above 2000 feet.

Calculate the percentage ratio of (d) to (c) : this will be required for comparison in the next lesson.

2. Make a sketch-map of the area defined in § 1, indicating, by an approximate boundary, land below and above 500 feet, inserting the main peaks, rivers, watersheds and towns, and tracing the course of the following railways :

Highland Railway

(1) From Blair Atholl (B.A.) by the Pass of Drumochter to Kingussie (K.) and Inverness (I.).

(2) From Aviemore (11 miles below K.) to Forres.

(3) From Inverness through Forres and Elgin (Eg.) to Keith (K.).

Great North of Scotland Railway

(1) From Aberdeen (A.) to Ballater (B.).



FIG. 24.—THE EASTERN HIGHLANDS OF SCOTLAND.
Contour-lines at 500, 1000 and 2000 feet above sea-level.

(2) From Aberdeen to Kintore (Ki.), Inverurie (Ir.), Huntly (H.) and Keith.

(3) From Inverurie to Turriff (T.) and Macduff (Ma.).

(4) From Aberdeen to Ellon (El.) and Fraserburgh (Fr.), with a branch to Peterhead (P.).

3. Make a sketch-map of the east coast of Scotland, including the Orkneys and Shetlands, and against the ports named below place black, red and blue dots, approximately proportional in size to the values given in the three first columns.

What is the only fishery in which the west coast of Scotland beats the east coast?

SCOTTISH SEA-FISHERIES, 1905.

Chief Ports.	Values.				
	Fish taken by nets (chiefly herrings).	Round Fish. ¹	Flat Fish. ²	Shell- fish. ³	Total.
	£1000	£1000	£1000	£1000	£1000
Aberdeen - - -	53	637	183	0	892
Shetland - - -	577	20	1	0	599
Leith - - - -	10	129	47	4	191
Fraserburgh - - -	141	7	1	1	150
Peterhead - - -	129	8	1	0	139
Wick - - - -	114	13	1	5	134
Other East coast ports } (including Orkney)	132	141	18	24	315
West coast - - -	196	50	12	37	300
Totals for Scotland -	1352	1005	264	71	2720

4. On an outline map of the eight counties in the upper table on p. 269, shade with horizontal lines of shading the four which have the greatest density of cattle; and with vertical lines the four which have the greatest density of sheep.

Keeping to the order in which the counties are arranged in the table, make a graphic representation of the variation in density of cattle and of sheep and the area of cultivation.

By reference to the map and graph, write out a statement of the geographical distribution in this part of Scotland of the things tabulated.

¹ Cod, haddock, whiting, hake, etc.

² Sole, plaice, brill, turbot, etc.

³ Oysters, mussels, etc., crabs and lobsters.

CATTLE AND SHEEP, 1907.

County.	Area.	Cattle.	Cattle. per 1000 Acres.	Sheep.	Sheep per 1000 Acres.	Percentage of Total Area Cultivated.
	1000 acres	1000		1000		
Inverness -	2695	50	18	554	197	5.5
Perth -	1596	72	48	687	410	21.2
Forfar -	559	51	94	183	303	44.6
Kincardine -	244	24	100	52	186	49.0
Aberdeen -	1262	167	134	246	170	49.9
Banff -	403	44	106	65	153	39.7
Elgin -	305	22	72	60	183	33.0
Nairn -	104	6	59	19	181	24.2

5. Represent the following statistics by percentage diagrams ; and compare them with those prepared for Southern Scotland in Lesson XLVII

OCCUPATIONS IN NORTHERN SCOTLAND, 1901.

Counties.	Percentage of Occupied Persons engaged in				
	Agriculture.	Fishery.	Making Metals and Machinery.	Textile Industry.	Mines and Quarries.
Shetland, Orkney, Caithness and Sutherland	6	40	2	12	2
Ross and Cromarty and Inverness	6	36	3	3	—
Nairn, Elgin, Banff, Aberdeen, and Kincardine.	7	24	4	4	2
Forfar, Perth, Fife, Kinross and Clackmannan	7	10	5	26	7
Stirling, Dumbarton, Argyll and Bute	7	11	17	5	9
England and Wales for comparison	8	—	9	8	6

6. Make a list of the peaks the altitude of which is marked on Fig. 84, in order from the highest downwards. When so arranged, what geographical order do they also show?

7. Make a list, in order of population, of all towns within the map having over 5000 inhabitants. In what part of the area do these all lie?

Glenmore—The **Highlands** of Scotland are composed in the main of a great mass of hard crystalline rocks, which form a lofty table-land, 2000 feet and more above the sea. Deep valleys and glens cut up this table-land into many divisions, but the deepest and sharpest of all dividing lines is that of **Glenmore** (the great glen) which separates the Eastern or Grampian Highlands from the North-West Highlands. The sea runs into this great cleft, from the south-west up Loch Linnhe and Loch Eil, and from the north-east into Moray Firth and Inverness Firth. Between Inverness and Fort-William (on Loch Eil), a distance of over 50 miles, Glenmore is occupied by a series of three lakes, two draining to the Moray Firth, and the other to Loch Eil. These lakes are little above sea-level, and the watershed is so low that the Caledonian Canal, which links them up, has very few locks on its course. Though easy to make, this canal is not of much use, as it does not form a route between any places of great importance.

The Eastern Highlands.—The great expanse of high ground of the Eastern Highlands is too bleak for cultivation of any sort. Large areas are only used as deer-forests or grouse-moors, and the month of August sees a great immigration of sportsmen, while the wildness of the scenery also attracts many tourists.

Although the moors of Perthshire and Inverness-shire are by no means so thickly populated with sheep as those of the Southern Uplands and North Wales, yet the total number of sheep within the area of those two large counties is very great, and Perth has one of the largest sheep-markets in the British Isles.

Rainfall and rivers.—The rainfall on the western (windward) side of the Highlands is very heavy, and as the highest ground

lies towards that side, the streams that run down to Glenmore or the sea are full and rapid. They constitute a source of power as yet turned to little account, but now being utilized for the electrical extraction of **aluminium** from its ore. This is done at Foyers (near Fort Augustus) by means of a natural waterfall, and at Kinlochleven, near Ballachulish (Fig. 86), by an artificial fall from a high-level reservoir on Rannoch Moor (Fig. 83). If coal were less plentiful in Britain the **water-power** of the Highlands might be utilized much more.

The rivers that flow to the north and east coasts are much longer, and each valley has an upper steep-sided portion or **Glen**, and a lower more open valley or **Strath**. Those flowing to the east coast flow for the most part due east, but those to the north coast flow roughly parallel to Glenmore, so that the Highland railway has to cut across the grain of the country to reach Inverness from the pass of Drumochter. The glens are almost uninhabited, except for shepherds' huts, shooting-boxes, and occasional whisky-distilleries. In the straths there is nothing larger than a village.

The coastal plain.—A line from the mouth of the Spey to that of the Dee cuts off the triangular area of **Buchan**, which is low-lying and very different in character from the highlands proper. The rainfall is low here, because the westerly and south-westerly winds have lost much of their water-vapour in crossing the highlands; consequently, in spite of cold springs, corn can ripen rapidly in the long dry summer days. This is therefore an agricultural district, and contains a number of market-towns. **Cattle-grazing** is also a great industry, "store" cattle from North America and Ireland being fattened here for the meat-supply of London and other large towns. Another important occupation of the coast-dwellers is **fishing**, herrings in particular being landed in enormous numbers; the curing of herrings and smoking of haddocks is carried on at most of the ports.

This triangle of low ground is separated from the Lowlands proper by a portion of the Highlands that run down to the sea from Aberdeen to Stonehaven, leaving a narrow passage along

the coast along which all the traffic must pass. At the crossing of the chief river in this narrow strip stands the important city of **Aberdeen**. From it roads and railways radiate in all directions in which there is land. The importance of its site is shown by its being an ancient University town. The rocks of the Highlands supply the material for a flourishing granite-quarrying industry; and it attracts to itself a large part of the fishing, and the building of fishing-boats; while even those boats that are built at the smaller ports on the east coast are sent to Aberdeen to be fitted with engines.

LESSON LIII.

THE NORTH-WEST HIGHLANDS AND ISLANDS.

1. Measure (*a*) the area of mainland on Fig. 85 lying west and north of the Inverness and Moray Firths and the line of Glenmore (of which they are the continuation). Measure the portions of this area (*b*) below 500 feet, (*c*) between 500 and 2000, (*d*) above 2000.

Calculate the percentage ratio of (*d*) to (*c*), and compare it with the corresponding ratio for the Eastern Highlands (Lesson LII.).

Describe in words the physical differences between the two Highland areas shown by these ratios.

2. Make a list of the highest peaks in order of altitude. Do their heights increase or decrease (*a*) from south to north, (*b*) from west to east?

3. Make a sketch-map of the North-West Highlands (area defined in § 1), showing the area above and below 500 feet, chief peaks, rivers and watersheds. Mark the course of the following railways, and write a description of each:

From Inverness (I.), through Dingwall (D.), Alness (Al.), Invergordon (Ig.), Tain (T.), Golspie (G.) and Helmsdale (H.) to Wick (W.), with a branch to Thurso (Th.).

From Dingwall to Strome Ferry (on L. Carron, beyond the limits of the map).



FIG. 85.—THE NORTH-WEST HIGHLANDS OF SCOTLAND. Contour-lines at 500, 1000 and 2000 feet above sea-level.

4. What is the least distance from the mainland to the Isle of Skye? to the Isle of Lewis? to South Ronaldsay in the Orkneys?

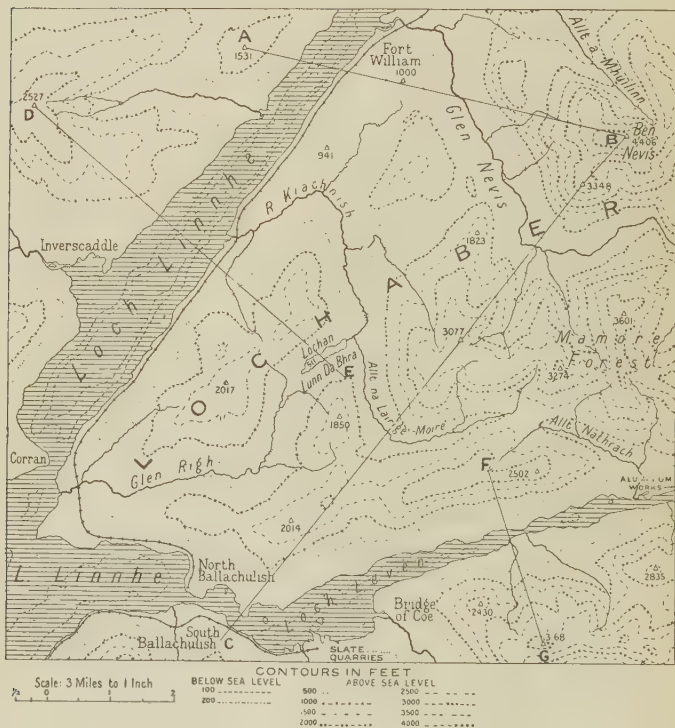


FIG. 86.—A PORTION OF THE WEST COAST OF SCOTLAND.

5. Examine Fig. 86. Find its place on the general map of Scotland. Make a tracing of the map, inserting only the 1000, 2000 and 3000 feet contours. Shade the area above 1000 feet lightly, above 2000 more deeply, and above 3000 black. Shade the sea a light blue, with a darker blue for depths of more than 200 feet.

6. Draw sections along AB, BC, DE and FG. The shorter sections should be drawn to a true vertical and horizontal

scale of one inch to a mile (5280 ft.), the horizontal measurements from the map being trebled. The longer ones may be drawn with horizontal scale the same as the map, and vertical scale either 1 inch = 5280 feet, or 1 inch = 5000 feet.



Photo.

G. W. Wilson.

FIG. 87.—BEN NEVIS AND FORT WILLIAM.

This view is taken from across Loch Linnhe, looking in a direction very nearly that of AB in Fig. 86. Glen Nevis can be recognized behind the first ridge of high ground.

7. Construct *true profile-sections* from this map, *i.e.* along lines which instead of running straight follow the natural *crest-lines* (watershed-lines) or *valley-bottoms*.

(a) As an example of a crest-line, draw a line from east to west along the crest north of Loch Leven, passing through the 2502 and 2014 points, keeping always to the highest ground it can find, and ending at the westward cape. Construct a profile along this to true scale, as above.

(b) Construct another along the line of the river Kiachnish, starting at its easternmost source, also to true scale.

(c) Construct another along the lowest depths of Loch Linnhe, from the northern edge of the map, through the Strait at Corran, and a little beyond. Scale—horizontal, same as map; vertical, 1 inch = 1000 feet.

What peculiar feature does Loch Linnhe show that distinguishes it from a submerged river valley? (Sea-inlets showing this feature are called **fjords**.)

A dissected plateau.—The Highlands beyond Glenmore rise to heights not much less than those of the Eastern Highlands; but a detailed orographical map shows that there are fewer broad areas of high ground: the land is more cut up by glens. On the other hand, there are no large rivers like the Tay, Dee and Spey; so with more numerous glens there are fewer straths. This makes the region even more sparsely inhabited than the country east of Glenmore.

The altitudes of the highest peaks decrease fairly steadily from north-west to south-east, so that, if a board were laid upon a model of the country, it would slope in that direction and would touch, or nearly touch, a large number of the summits. Such a board would represent the original surface of the **plateau** which has been cut up or **dissected** by the action of running water. The Eastern Highlands show the same kind of dissection in a less advanced stage.

Firths.—The strip of fertile coastal plain along the south coast of the Moray Firth is continued on its west coast. It is cut into by three long inlets of the sea—Inverness and Beauly Firth, Cromarty Firth and Dornoch Firth, which compel the Highland railway to make great bends round them. The first and second of these curve round towards one another, and the peninsula between them is known as the Black Isle. These firths are shallow, and have been to a large extent filled up by the alluvium deposited by the streams flowing down from the Highlands. A marked feature on the hill-sides bordering the firths are the **raised beaches**—terraces cut in the hill-side and covered with sea-shingle, showing that they were once at sea-level, though now in different cases from 15 to 100 feet above it. These raised beaches, as well as the alluvial flats at the head of the firths, make good agricultural land.

These firths all have narrowed openings, but while in the cases of Inverness and Dornoch Firths this is due to spits of sand thrown up by the waves, in the case of Cromarty Firth

the opening has been cut through a ridge of hard rock which runs along the eastern edge of Black Isle and is continued beyond the firth, ending in the promontory of Tarbat Ness. What looks like the proper continuation of Cromarty Firth is a strip of lowland east of this ridge, ending near the mouth of Dornoch Firth. The agricultural district along these firths supports a number of small market-towns, but the most important place is **Inverness**, commanding the northern end of Glenmore.

Glenmore.—The strategic value of Glenmore, in the days when the Highlands championed the Stuart cause against the Georges, is shown by the names of the two chief places along its course—**Fort William** (Fig. 87) and **Fort Augustus** (with which must be counted **Fort George** and **Fortrose** at the mouth of **Inverness Firth**); and the fact that these are only small towns, or villages, shows how thinly populated must be the districts to which they serve as centres.

Caithness.—In the far north-east of Scotland another low-lying agricultural area of old red sandstone occurs in Caithness; but this only supports two small towns, **Wick** and **Thurso**, and these are in large measure fishing ports, many herrings being landed there. Another local product is paving-stone, the Old Red Sandstone of Caithness containing beds which split into very suitable slabs.

West Coast and Hebrides.—While the east coast is relatively dry, the west coast is the rainiest part of the British Isles. The land keeps high to near the sea-margin, which is cut into by numerous sea-lochs, which are deep and steep-sided, quite unlike the firths on the east coast, and exactly like the **fjords** of Norway. Fjords have the peculiarity that they do not deepen continuously seawards as do ordinary submerged valleys, but have a bar of shallower water separating their deepest part from the sea. While they are certainly submerged or “drowned” valleys, some other process than simple submergence must have taken place to produce this feature.

Along such a coast railways can only be carried for short distances. Communication is far more conveniently carried

on by steamboats. Only three railways reach the west coast, crossing from the east or the lowlands. The Callander and Oban railway from Stirling serves the port of **Oban**, on the Firth of Lorn opposite the Island of Mull. This is the chief steamboat centre and only important town on the west coast of the Highlands. The West Highland railway runs through Fort William to Mallaig, on the Sound of Sleat, separating the Island of Skye from the mainland; and a branch of the Highland railway runs across the land to Strone Ferry, on Loch Carron (whence boats run to Stornoway in the Outer Hebrides), and to Loch Alsh, close to the Island of Skye.

On this west coast there is little land level enough for agriculture, nor is there enough summer sunshine to ripen crops. Except at the railway termini, or where there are slate- or granite-quarries, little fishing villages are all that the coast can support. There are many small islands that have been separated from the mainland either by the destructive action of the sea, or by the depression which has turned valleys into fiords, and has sometimes united two of them across a low pass and so cut off an island. The large islands of **Skye** and **Mull** are thus separated from the mainland by channels no wider than many of the lochs. These and other islands not far from the coast constitute the Inner **Hebrides**. The Outer Hebrides are a row of islands separated from Scotland by a deep and broad channel, the **Minch**. The largest of these islands is peculiar in having no name as a whole: its largest northern part is called Lewis, the southern part Harris. **Stornoway** is the only town. Lobster and other fisheries are the chief support of the islanders; but they also raise sheep, spin wool, and weave cloth of good quality—Harris tweeds.

Orkney and Shetland.—The Orkney Islands are separated from Caithness by the Pentland Firth, about 10 miles broad, through which the tidal current sweeps with great force. The Shetlands are 50 miles from the Orkneys. In both island-groups the industries are the same as in the Outer Hebrides, namely fishing and weaving. In addition, Shetland is famous for its very small and very hardy breed of ponies.

LESSON LIV.

IRELAND.

1. Write out a comparison of the kingdoms of Scotland and Ireland in a series of sentences framed in these general terms:

"Ireland has approximately the same as Scotland."

"Ireland has much less (or more) than Scotland."

"Ireland has a more uniform than Scotland."

COMPARISON OF SCOTLAND AND IRELAND, 1907.

	Scotland.	Ireland.
Total area (1000 acres) - - - -	19,070	20,711
Percentage of total cultivated - -	25.6	73
Percentage arable of total cultivated -	70	31
Percentage of arable given to wheat -	1	1
" " " barley -	6	4
" " " oats -	28	23
" " " potatoes -	4	13
Cattle per 1000 acres - - - -	63	228
Sheep per 1000 acres - - - -	366	183
Pigs per 1000 acres - - - -	8	61
Highest average county rainfall - -	66	58
Lowest " " " " - -	27	32
Population per 1000 acres - - - -	235	219
Densest county population per 1000 acres	2,379	694
Least dense county population " -	17	117

2. Shade an outline county map of Ireland to show density of population, on the same scheme as for Scotland (Lesson XLVII., p. 243), viz.:

Counties with less than 100 persons to 1000 acres (unshaded)—none.

Counties with from 100 to 250 persons to 1000 acres (lightly shaded)—all except those named below.

Counties with from 250 to 1000 persons to 1000 acres (darkly shaded)—Antrim, Armagh, Down, Dublin, Londonderry, Louth.

Counties with over 1000 persons to 1000 acres (black)—none.

3. Shade another outline county-map to illustrate the proportion of the land that is ploughed, viz.:

Less than 15 per cent. (blank), Galway, Kerry, Mayo;

From 15 to 30 per cent. (lightly shaded), Cavan, Clare, Cork, Donegal, Farmanagh, Kildare, Kilkenny, King's, Leitrim, Limerick, Longford, Meath, Roscommon, Sligo, Tipperary, Tyrone, Waterford, Westmeath, Wicklow;

Over 30 per cent. (darker), Antrim, Carlow, Dublin, Londonderry, Louth, Monaghan, Queen's, Wexford;

Over 40 per cent. (very dark), Armagh, Down.

4. Using the table given below, represent the cultivated area in each of the four countries by an inch square. Divide this inch into two parts differently shaded, to represent arable and pasture. Add on one side of each square an area proportional to the amount of woodland, and on the other side one proportional to the uncultivated area.

PROPORTION OF THE DIFFERENT KINDS OF LAND IN THE CHIEF DIVISIONS OF THE BRITISH ISLES, 1906.

(Calculated as percentages of the agricultural area).

	England.	Wales.	Scotland.	Ireland.
Arable - - -	46.5	32	72	20
Pastoral - - -	53.5	68	28	80
Woods, etc. - -	7	6.5*	18	2
Uncultivated - -	32	70	291	31.5

5. **Local time** (as shown by a sun-dial after correction for the equation of time) varies with the longitude, but not with the latitude, being 4 minutes ahead for every degree east of Greenwich, and 4 minutes behind for every degree west of Greenwich.

Find the true local time at the following places when it is noon by Greenwich time—

Canterbury, Boston, York, Reading, Berwick-on-Tweed, Stirling, Cape Wrath, Pembroke, Dublin.

6. In Ireland, Dublin time is kept. Find the true local time when it is noon by Dublin time at Belfast, Galway, Queenstown, and Dingle.

Ireland is slightly larger than Scotland (32,000 square miles as against 30,000), and its population is about the same at the

present time ($4\frac{1}{2}$ millions; less than that of London). These two points of superficial resemblance cover a host of differences. As regards population, there are two very real differences. In the first place, the $4\frac{1}{2}$ millions of Scotland have been reached by a steady increase since statistics were first taken; those of Ireland are the result of a fifty years' decrease. In 1841 the population of Ireland was over 8 millions, more than three times that of Scotland at the same date. Secondly, at the present time there is no part of Ireland so thinly populated as are the Scottish Highlands, nor any (outside the actual cities) so thickly populated as many parts of the Scottish Lowlands. The population of Ireland, in fact, is very evenly distributed.

Mere resemblance of size is of no importance when there are such differences in surface relief. It is true that the northern and southern parts of Ireland, like those of Scotland, are more mountainous than the central part, but there is in Ireland no large area of continuous high ground like the Highlands, while the centre of Ireland is a true plain, without any of the high hills that break up the Lowlands of Scotland. Very little of this central plain is seen from the sea, which beats against a mountainous coast nearly all round the island.

Geology.—On the geological map, the centre of Ireland is shown as composed mainly of Carboniferous Limestone, while on the north and north-east, south and south-east, are seen areas which appear to be the geological continuations of the adjacent areas of Great Britain. Donegal appears to be the continuation of the Scottish Highlands; while from County Down inland runs a continuation of the rocks of the Southern Uplands. Between these two is the great volcanic area of Antrim, which finds its continuation in Mull and Skye. In the south-east, the Leinster mountains are of the same rocks as those of Central Wales, except for the great granite range on their inland border; and the Old Red Sandstone area of the south shows similar geological structure to parts of South Wales and the Mendip Hills.

In one respect the geological map is misleading, for Ireland

is more completely covered with drift, largely glacial, than either England or Scotland, and the rocks marked on the map really only come to the surface in scattered patches.

Coalfields are few and small in Ireland. For this reason it cannot, in existing conditions of industry, be a manufacturing country in any large degree.

Climate.—The climate of Ireland differs from that of Great Britain, chiefly in its greater uniformity. In the absence of any large areas of continuous high ground, the south-west winds do not deposit the main part of their rain on first reaching land, but retain much vapour to be condensed farther east. Thus the rainfall is much more equally distributed than in Great Britain, and while there are no parts quite so rainy as the Inner Hebrides or Cumberland, there are none quite so dry as the east coast of England. This general rainfall of about 40 inches annually is more suitable for the growth of grass than of corn, and Ireland has been called the Emerald Isle from the greenness of its pastures. In the Middle Ages cattle, not corn or arable land, was the standard of wealth. "In Irish law, fines, dues, rents were all paid in live stock and generally in kine . . . and even at the opening of the sixteenth century we find an Earl of Kildare paying twenty cows as the price of a book" (J. R. Green, *The Making of England*, vol. ii. p. 32). At the present day, cattle are the chief export of Ireland (to Great Britain).

Provinces.—From ancient times five provinces, which correspond to natural divisions, have been recognized in Ireland. The mountainous northern part is **Ulster**. The Central Plain is divided by the broad Shannon with its lakes into **Meath** on the east and **Connaught** on the west; the latter including also the mountainous region of Connemara and Mayo. The mountainous south-east was **Leinster**, and the south-west, **Munster**; but in both these, as well as in Ulster, were included adjoining portions of the plain. Since the English conquest of Ireland, Meath has been merged in Leinster.

Irish Time.—As Ireland lies to the west of England, all the natural events of the day happen later there—sunrise, noon

and sunset, and their consequences in the doings of the people. The same is true of Wales as compared with England ; but for all doings that are regulated by clocks and watches, all parts of Great Britain follow Greenwich time instead of their own local time. Ireland, on the other hand, keeps Dublin time, and as Dublin is a little more than 6° (a sixtieth of the circumference of the earth) west of Greenwich, its time is 25 minutes (24 minutes is a sixtieth of 24 hours) behind Greenwich time.

LESSON LV.

ULSTER.

1. On Fig. 88, measure and state in square miles the areas of the Bann basin, the Laggan basin, Lough Neagh and Lough Erne. Measure the length of each of these lakes from the point of inflow of the main river to its point of outflow. Find in each case whether this is the greatest length of the lake, and, if it is not, measure and state the direction of the greatest length.

Write out in parallel columns a comparison of the two lakes in respect of (*a*) shape, (*b*) direction of inflow of chief tributaries and their relation to the shape of the lake.

2. Follow the watershed that runs nearly parallel to the east coast from north to south. What is its average distance from the coast, north of Belfast Lough? What is its average altitude in the same part? What is the average gradient from it to the coast? How many times does it sink below 500 feet? How many of these gaps are more than two miles wide (as measured from the 500-foot contour-line)? What river-valley corresponds to the widest gap? What is the easiest route (crossing as few watersheds as possible, and never rising above 500 feet) from the Erne basin to the east coast? At what port does the route end? What is its population?

3. What two rivers afford the easiest routes from the Erne basin to the *north* coast? What two towns stand near the mouths of these rivers respectively? What are their populations? What advantages has the larger one over the other, as a port? What advantage has Belfast over them both as regards trade with Great Britain?

4. On an outline county map of Ireland shade lightly those counties with from 0.1 to 1 per cent. of their area devoted to flax-growing; more deeply those with from 1 to 3 per cent.; and very deeply those with over 3 per cent.

FLAX-GROWING IN IRELAND, 1906.

Counties of Ulster.	Population per 1000 Acres.	Acres per 1000 Devoted		Counties of Ulster.	Population per 1000 Acres.	Acres per 1000 Devoted	
		To Flax.	To Wheat.			To Flax.	To Wheat.
Antrim -	276	48	1.5	Monaghan -	234	22	1.1
Armagh -	400	39	3.5	Tyrone -	193	38	1.5
Cavan -	209	9	0.7	<i>Other Provinces :</i>			
Donegal -	146	27	0.1	Connaught -	—	less than 0.02	1.3
Down -	336	42	10.8	Leinster -	—	„ „	3.0
Fermanagh -	156	3	1.2	Munster -	—	„ „	1.1
Londonderry	281	52	1.7				

5. Describe and illustrate by a sketch-map the course of the following railways and canals :

Great Northern (of Ireland) Railway, from [Dublin and] Newry (N.) through Tanderagee (T.) to Portadown (P.), Lurgan (Lu.), and Lisburn (Lb.) to Belfast (B.).

G.N.R., from Portadown through Dungannon (Du.), Omagh (O.), Newton Stewart (N.S.) and Strabane (St.) to Londonderry (L.).

G.N.R., from Portadown through Armagh (Ar.) and Monaghan (M.) to Clones (Cl.) [and Cavan].

G.N.R., from [Dublin and] Clones through Newton Butler (N.B.) and Enniskillen (En.) to Omagh and Londonderry.

Belfast and Northern Counties Railway (Midland), from Belfast through White Abbey (W.A.), Antrim (A.), Ballymena (Bm.), Ballymoney (By.), and Coleraine (Co.) and near Limavady (N.L.) to Londonderry.

B.N.C.R., from Belfast through White Abbey and Carrickfergus (Cf.) to Larne (La.).

Ulster Canal, from L. Neagh, through Monaghan and Clones to the Erne.

6. Make a sketch-map of the adjoining parts of Scotland and Ireland, including Inverness in its north-east corner, Coleraine on the west and Belfast on the south. Mark on it the position of the Aluminium-ore district of Ireland, and the Iron-ore of Ballymena, the Ayrshire coalfield, and the aluminium works at Foyers and Kinlochleven. Indicate by arrows the industrial connexions between the two sides of the Irish Channel :

Aluminium-ore from Ireland to Foyers and Kinlochleven.

Iron-ore from Ireland to Ayrshire.

Coal and iron from Ayrshire to Belfast (for ship-building and engineering work).

Ulster.—The province of Ulster consists of several distinct geological regions : (1) Donegal, a mountainous area of crystalline rocks ; (2) the basalt plateau of Antrim and Londonderry ; (3) the Laggan valley of New Red Sandstone ; and (4) the area of ancient grits and slates in Counties Down, Armagh, Monaghan and Cavan.

The last of these areas is the geological continuation of the Southern Uplands of Scotland, but it is only the masses of granite which here rise into mountains (**Mourne Mountains** and others) ; the slates and grits are worn down into fairly low ground, as in the Wigtownshire end of the Southern Uplands. Consequently we do not here find extensive sheep-moors, and as the soil is less fitted for grass-growing than almost any other in Ireland, it is very largely ploughed. Half the wheat of all Ulster—one-seventh that of all Ireland—is grown in County Down ; but even more important than wheat is **flax**, a plant rarely grown in Great Britain.

On the north-west border of the area just described lies a strip of New Red Sandstone, forming the Lagan valley. As its soil is enriched by materials derived from the primary rocks on one side and the basalts of the plateau that rises on the other, this valley is one of the richest fattening grounds for cattle in Ireland. It is also an important line of communication, linking Belfast Lough with the valley of the Bann by a low pass.

A lava-plateau.—The great basalt-plateau of Antrim is formed from only a portion of an immense series of sheets of lava which once flowed over land now under the Atlantic, the basalts of the Inner Hebrides being other parts of the same, as is shown by the close resemblance of the basaltic columns of the two famous places—the **Giant's Causeway** in Antrim, and Staffa in



FIG. 89.—THE GIANT'S CAUSEWAY.

From a photograph by the late Mr. A. E. V. Zealley.

the Hebrides. These hexagonal columns are the result of the shrinkage in the lava as it cooled down: drying mud and starch-paste will sometimes crack in a similar way. A depression in the basalt plateau is occupied by Lough Neagh, which is not only the largest lake in the British Isles, but one of the largest in Europe. The river Bann rises in the granitic Mourne Mountains near the east coast, and flows northward through Lough Neagh to the north coast. The Newry river flowing south-east and the Lagan flowing north-east, are separated from the Bann basin by low passes in the district south

of the lake, while a tributary of the Bann, the Blackwater, affords a westward route to the Erne and Shannon basins. Canals link up these rivers, and Portadown, south of Lough Neagh, is an important railway junction.

Aluminium ore.—Eastern Ulster is the chief mineral district of Ireland. After a lava-sheet had been poured out, its surface



Fig. 90.—PLEASKIN HEAD, GIANT'S CAUSEWAY.

From a photograph by the late Mr. A. E. V. Zealley.

The step-like appearance is due to a series of lava-flows, each forming one step. The uppermost lava shows columnar structure, less perfect than that shown in Fig. 89. Between the lava-flows are thin layers containing iron- and aluminium-ores.

underwent decay of a peculiar kind, such as now takes place in tropical climates, and the decomposition-products include good ores of aluminium and iron, mined chiefly at Ballymena and Glenarm. There are small coalfields, on the coast at Ballycastle (which also produces **clay-iron-ore**) and in East Tyrone. But no smelting is done in Ireland—the iron-ore is shipped across to Ayrshire, the aluminium ore to Kinlochleven (near Ballachulish) and Foyers on the Caledonian Canal. The granite of Newry is largely quarried for export to England.

Linen.—As flax is the most remarkable product of Ulster, so **linen-weaving** is its most notable industry. Irish linen is unsurpassed for whiteness, which is attributed to the climate. The local-grown flax is insufficient for the looms, and it is imported from Russia, Germany, Holland, France and elsewhere, to which countries among others the made linen is exported. Some of the finest weaving is done in small towns, as **Armagh**, but the large linen-factories are in the large towns, **Belfast** and **Londonderry**. Shirt-making is a special industry of the latter town and many of the villages round about it. The other staple industry of Belfast is **ship-building**, in which it takes a high rank. It relies on Ayrshire for the coal and iron it needs for this work.

This part of Ireland has a number of long inlets of the sea, here called **Loughs** (pronounced the same as the Scotch Lochs). As Ireland has not much direct trade with America, the chief ports are those that look towards Great Britain. **Moville**, on Lough Foyle, however, is a port of call for Canadian liners. Unfortunately the harbours on the Irish Sea have a great tendency to silt up. Belfast is the chief port, but some of its passenger traffic is carried on through **Larne**, from which mail-steamers run to Stranraer. Greenore, on Carlingford Lough, is in communication with Holyhead.

The extreme west of Ulster, **Donegal**, has many points in common with the Hebrides. The soil is thin and stony, the climate wet. Sheep are largely reared on the hills, and the Donegal homespuns rank with Harris tweeds. Agriculture, too, is difficult, and the population, though scanty, is more than the land can support without extensive improvements, which the people are too poor to make. Such areas are known as "**Congested Districts**": they are under the care of a special Government Department, which is doing much to improve the roads and bridges, build light railways, and reorganize the agriculture and fisheries, so that the people may be supported in greater ease on the land. The congested districts of Ireland lie west of a line drawn from Londonderry to Galway, and another from Tarbert (on the Shannon estuary) to Baltimore on the south coast.

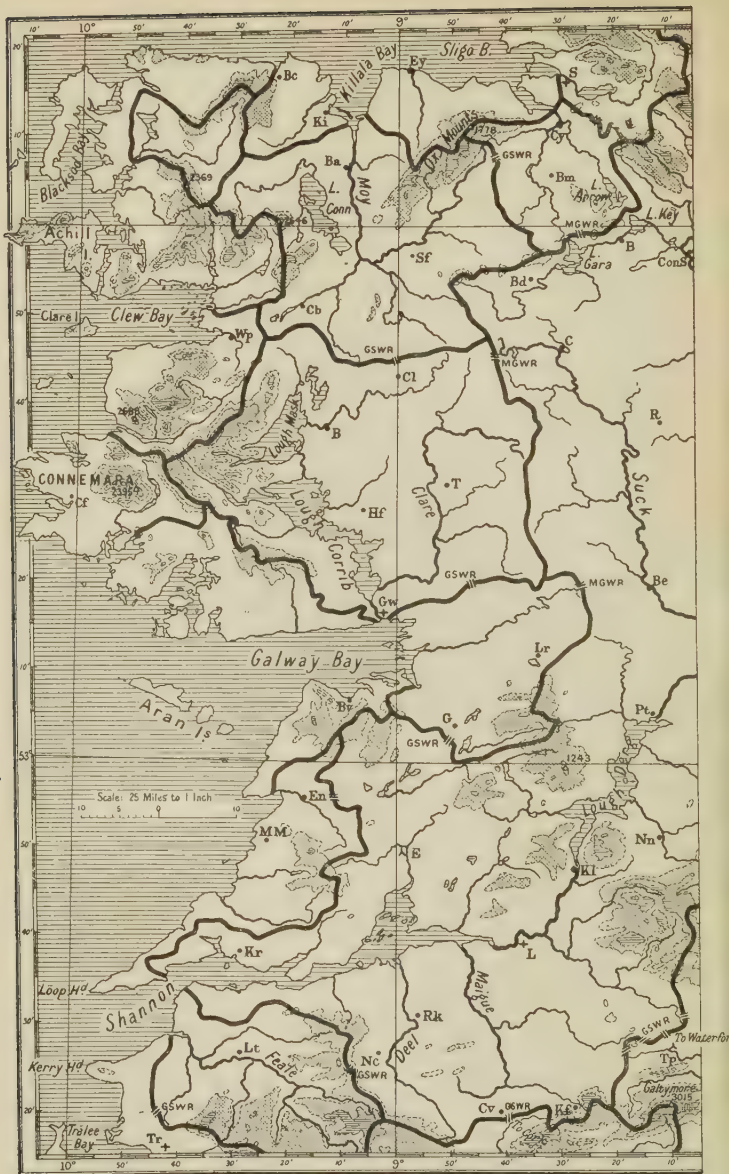


FIG. 91.—WESTERN IRELAND.
Contour-lines at 500, 1000 and 2000 feet above sea-level.



FIG. 92.—CENTRAL AND EASTERN IRELAND.
Contour-lines at 500, 1000 and 2000 feet above sea-level.

LESSON LVI.

THE IRISH PLAIN.

1. Measure the area of the Shannon basin, so far as it lies within Figs. 91-92. (By careful comparison with Fig. 88, it will be seen that only an insignificant area is excluded.) Measure the width of the basin in lat. $53^{\circ} 30'$ N. Measure the width of the Shannon valley below 500 feet altitude (*a*) at the north end of Lough Allen, (*b*) at Killaloe (Kl.). Measure the areas of Loughs Allen, Ree and Derg.

2. Trace the course of the Shannon on the geological map. Divide it into sections according to the geological formations it traverses. Tabulate these sections, writing against each (*a*) its approximate length, (*b*) geological formations, (*c*) openness or narrowness of valley. Make a sketch-map to illustrate these features.

3. Find portions of the east coast of Ireland (within Fig. 92) in which the land does not rise to 500 feet within 15 miles. How many such portions are there? In which of them does the ground rise least inland? For each of them make a list of the important rivers entering the sea within its limits. Which of these rivers have ports at their mouths? Which of these ports appear to have the best harbours? Which command the easiest routes to the interior? Which two are nearest to Great Britain? Explain, by reference to these three characters, why Dublin has so much greater a population than the other ports.

4. Describe and illustrate by a sketch-map the course of the following railways and canals:

G.N.R. (of Ireland), Dublin (D.) through Balbriggan (Bb.), Drogheda (Dr.), Dundalk (Dd.), to near Newry (Ny.) and on to Portadown and Belfast.

M.G.W.R., Dublin through Maynooth (Mn.), Mullingar (M.), Athlone (At.), and Ballinasloe (Be.) to Galway (Gw.).

G.S.W.R. (1) Dublin through Kildare (Kd.), Portarlington (P.), Maryborough (Mb.), Templemore (Tm.), Thurles (Th.), Limerick Junction (on the watershed near Tipperary (Tp.), to Charleville (Cv.) and Cork.

(2) From Rosslare (R.) through Waterford (Wf.), Carrick-on-Suir (C.-on-S.), Clonmel (Cm.), Caher (Ca.), Tipperary and

Limerick Junction to Limerick (L.), Ennis (E.), Gort (G.), Tuam (T.), Claremorris (Cl.), Swineford (Sf.) and Collooney (Cy.) to Sligo (S.).

D.S.E.R., Dublin through Kingstown (Kn.), Bray (B.), Wicklow (Wl.), Arklow (Ar.), Gorey (Gy.) and Enniscorthy (En.) to Wexford (Wx.) and Rosslare.

Royal Canal, from Dublin through Maynooth and Mullingar to the Shannon at the north end of Lough Ree.

Grand Canal, from Dublin through Naas (N.) and Tullamore (Tm.) to the Shannon at Banagher (Bn.).

5. On one outline map of Ireland shade those counties darkly that have over 16 per cent. of their area bog and marsh; those lightly that have from 9 to 16 per cent. inclusive; leaving those with 8 per cent. or less blank.

On another map shade similarly according to the percentages of barren mountain.

DISTRIBUTION OF BOG AND BARREN MOUNTAIN IN IRELAND, 1901.

County.	Percentage of Area.		County.	Percentage of Area.	
	Turf-bog and Marsh.	Barren Mountain.		Turf bog and Marsh.	Barren Mountain.
LEINSTER :			ULSTER :		
Carlow -	1	5	Antrim -	4	8
Dublin -	—	7	Armagh -	3	3
Kildare -	9	—	Cavan -	4	2
Kilkenny -	2	2	Donegal -	12	29
King's -	22	1	Down -	1	7
Longford -	14	—	Fermanagh -	5	5
Louth -	1	6	Londonderry	5	9
Meath -	2	—	Monaghan -	3	—
Queen's -	6	5	Tyrone -	6	14
Westmeath -	9	1	MUNSTER :		
Wexford -	1	3	Clare -	4	11
Wicklow -	3	21	Cork -	5	13
CONNAUGHT :			Kerry -	10	27
Galway -	12	16	Limerick -	2	4
Leitrim -	7	8	Tipperary -	4	6
Mayo -	24	18	Waterford -	4	17
Roscommon	14	1			
Sligo -	9	14			

6. Shade an outline map of Ireland to illustrate the density of cattle :

Counties with over 300 cattle to 1000 acres (shade black)—Dublin, Limerick, Meath.

With from 250 to 300 (shade darkly)—Armagh, Cavan, Cork, Down, Kilkenny, Monaghan, Tipperary, Waterford, Westmeath.

With from 200 to 249 (shade lightly)—the rest of Ireland, except as stated below.

With less than 200 (leave unshaded)—Donegal, Galway, King's, Mayo, Queen's, Wicklow.

Deficiency of cattle may be due either to the presence of much mountain-land or much bog. Compare this map with the two previously made, and state to which of the last six counties these explanations respectively apply.

A limestone plain.—The Irish Plain differs altogether in character from the English plains. The latter have usually clay as their subsoil, sometimes sand ; limestone only occurring in higher ground. The Irish Plain, on the other hand, has a limestone foundation, though, like most of the English plains, it is largely overspread with glacial drift. As a low-lying limestone area it has very different characters from those of English limestone areas. These are dry, because the rainfall readily sinks into the fissures and caves of the limestone, and much of the natural drainage is carried by underground channels, streams being often only found in the lowest valleys. But when the surface of the limestone is little above sea-level, it is saturated with water up to the surface or near it, and there is as much surface-water as in a clay-plain. Limestone is dissolved by water containing carbon dioxide, and in this way are produced two features of the Irish plain—**lakes** which are solution-widenings of river-courses, and **bogs**, which are old lakes filled with bog-moss, living above and dead below. The soil on the limestone is thin, but owing to the greater dampness bears much richer grass than English limestone hills, and is suitable for grazing "**store**" **cattle**, that is, cattle not immediately intended for killing. These cattle are afterwards fattened on richer soils, like the Laggan Valley or the country west of Dublin, or exported to England or Scotland to be

fattened there. The greatest cattle-market in Ireland is at **Ballinasloe** on the Suck.

Drainage.—The relation of the river-system to the plain is peculiar. The **Shannon**, the longest river in Ireland, rises in the hills on the north of the Plain, where patches of Coal-Measures and Millstone Grit rest upon the limestone, thus repeating the structure of Whernside and the Lancashire and Yorkshire Moors. (Compare Fig. 93 with Fig. 72.) It flows southwards right across the plain, penetrates by a narrow gorge into the hills of Munster, and then turns westward to its estuary. At the lowest bridged point stands the important market-town and port of **Limerick**. Although outside the plain proper, the navigability of the Shannon brings Limerick into easy communication with it, and there is also, to the south, the richest grazing ground in all Ireland, the “Golden Vein,” where the soil is enriched by the mixture of material from the Old Red Sandstone hills around. Limerick is thus an important market-town and port. It has also a considerable industry in tanning and harness-making (partly from Irish, partly from South American hides) and in bacon-curing.

The watershed of the Shannon basin is, in many places, ill-defined, and bogs often lie upon it, the water from them draining partly to one basin and partly to another. The largest area of bogland is the **Bog of Allen**, which lies across the watershed between the Shannon, Boyne and Barrow basins.

The accumulation of dead bog-moss on the floor of a bog is known as **peat** (or turf). Peat is the chief fuel of Ireland, and its abundance is some compensation for the scarcity of coal. Dried loose peat or moss-litter is very absorbent and is much used as a dry flooring for cattle-sheds and the like; peat-fibre or “peat-wool” is used, mixed with cotton or wool, for weaving coarse fabrics; it is used to absorb molasses (crude sugar-syrup) for feeding animals who would not eat sugar in any other form; and tar, oil, alcohol and ammonium salts can be got from it by distillation. Attempts have been made to utilize it for various other purposes, such as paper-making, but without much success.

Another useful product of the bogs is **bog-iron-ore**. The acids formed in the decay of peat dissolve out the iron from the rocks beneath, and it is redeposited in the form of brown oxide. This is not now used as a source of iron, but is exported in large quantities to be used for purifying coal-gas, the iron-ore, by



Photo.

R. Welch.

FIG. 93.—AN IRISH BOG, GRANGE, SLIGO.

Compare the piles of turf with those shown in Fig. 68.

Comparing this view with Fig. 72, in both cases isolated flat-topped mountains stand upon a limestone plain. In this case, however, the heights are also of limestone. The difference in the foregrounds is due to the fact that, though both are composed of Carboniferous Limestone, the one is little above sea-level and waterlogged, while the other is high and dry.

absorbing all the impurities it can, becoming a further source of various useful chemicals.

Communications.—The Irish Plain is largely shut off from the sea by the mountains of Connaught. It only reaches the coast in Galway, Clew and Sligo bays, where stand the small ports of **Galway**, Westport and Sligo. They are small, because the country behind them is not populous, and because they face no land nearer than America. Galway Bay, with the Aran

Islands as a natural breakwater, has the possibilities of a great port, as there is no place in the British Isles from which a straighter course can be made to America. The utilization of Galway as a port depends entirely upon the maintenance of swift railway communication with the great cities of Great Britain, and at present the break in transit caused by the Irish Sea is too great an obstacle. If a tunnel is constructed between England or South Scotland and Ireland, Galway may become an important place.

The main outlet for the trade of the Irish Plain is eastwards, towards England. Here at the mouth of the Boyne stands the little port of Drogheda, and further south, taking by far the greatest part of the whole commerce of central Ireland, is Dublin.

LESSON LVII.

DUBLIN AND THE SOUTH OF IRELAND.

1. Examine Fig. 94. What is the most frequent direction in which the rivers flow in the central part of the map? What change in direction do the chief rivers or their estuaries make before reaching the open sea? In what direction do the inlets of the sea run in the western part of the map?

2. Examine the same district on the geological map of the British Isles. On what formation are the long straight courses of the main rivers? What formation constitutes the main watersheds? What formation do the rivers cross when they make the abrupt bend in their course? What formation forms the peninsulas between the long sea-inlets on the south-west? What formation probably underlies the latter? What resemblances can you see between this river-system and that of the Weald? What differences?

3. Examine Fig. 95 and identify its area on Fig. 94. Which of the three geological formations shown on Fig. 95 are united under a single colour on the small-scale geological map? Trace the course of the Lee from Cork to the open sea at Roche's

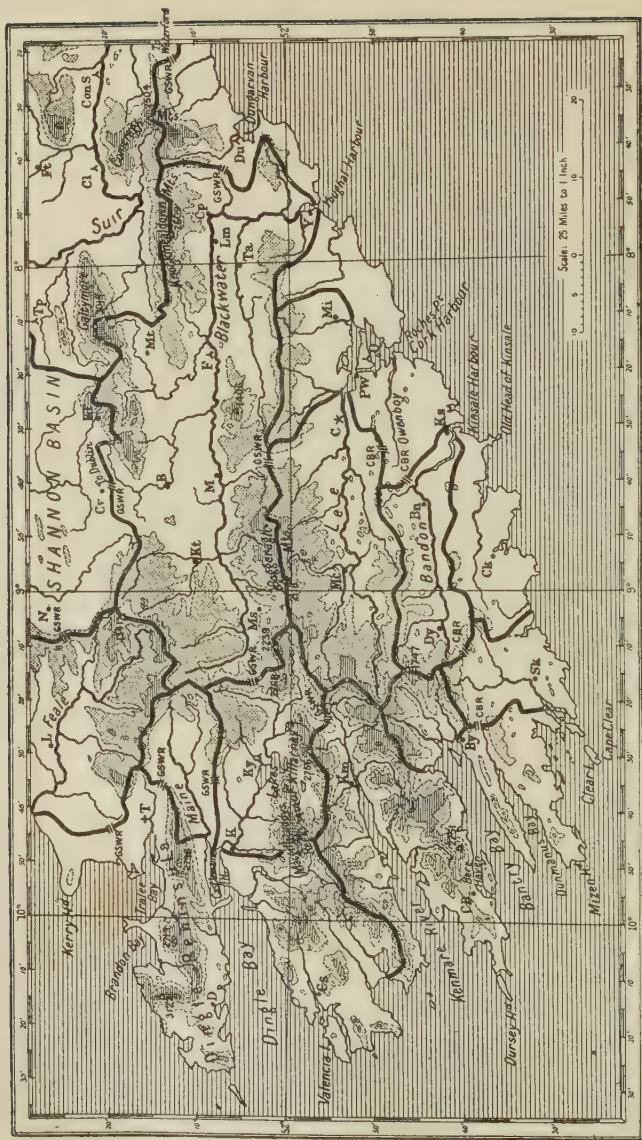


FIG. 94.—THE SOUTH-WEST AND SOUTH OF IRELAND.
Contour-lines at 500, 1000 and 2000 feet above sea-level.

Point: in crossing which formation is it narrowest? In which does it widen out? From what you know of the physical character of the latter rock, can you suggest an explanation of how this widening has been produced?

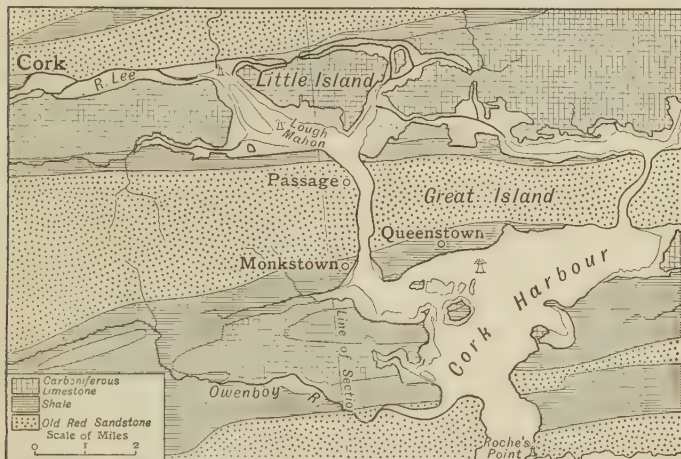


FIG. 95.—GEOLOGICAL MAP OF THE NEIGHBOURHOOD OF CORK.

The finely-dotted areas are between low- and high-water levels.

4. Examine Fig. 96, and carefully compare it with the line of section on Fig. 95. How many times larger is the vertical than the horizontal scale? How would you describe the



FIG. 96.—SECTION ACROSS THE LAND WEST OF CORK HARBOUR.

The actual line of section is shown on Fig. 95.

structure shown by the section? Look at the general geological map, and copy as much of the South of Ireland as seems to you to show a similar structure. On your sketch-map write the words "dome" and "basin" (or anticline and syncline) wherever you think they describe the structure.

5. Calculate the percentage of each class of live stock in Ireland which is exported to Great Britain in a year.

LIVE-STOCK TRAFFIC BETWEEN GREAT BRITAIN AND IRELAND.
YEARLY AVERAGE 1901-05.

Thousands	Horses.	Cattle.	Sheep.	Pigs.
From Ireland to Great Britain -	27	804	833	535
From Great Britain to Ireland -	8	1	36	—
Total number of thousands in Ireland at one time (1906) -	604	4639	3715	1244

6. Represent by percentage-diagrams the statistics given below, uniting "Live Stock" with "Agriculture," and keeping only this and the following five occupations separate, and uniting the rest with "other occupations."

In what occupations does Leinster show the highest percentage? Do you think this is in each case due to the presence of Dublin in Leinster? Give reasons for your opinion.

What are the most characteristic features of Ulster, Munster, and Connaught respectively, as shown by the above tables?

PRINCIPAL OCCUPATIONS IN IRELAND, 1901.

Engaged in	Number of Thousand Persons in			
	Ulster.	Munster.	Leinster.	Connaught.
Agriculture - - -	283	214	176	182
Live stock - - -	5	9	5	2
Textile industries - -	92	7	9	2
Dress of all kinds - -	74	23	31	10
Food and lodging - -	24	16	24	4
Houses, furniture, etc. -	22	12	21	3
Domestic service - -	59	61	83	16
Transport - - -	20	13	23	2
Commerce - - -	16	7	15	1
Professions - - -	18	15	25	6
Government - - -	9	9	13	4
Army and Navy - -	6	13	13	1
Other occupations -	103	57	89	18
Total occupied - -	731	456	527	251
Total population - -	1584	1076	1153	647

Dublin.—Unlike the West coast, the East coast meets the Irish Plain by a broad margin, between the Mourne and Carlingford mountains on the north and the Leinster mountains on the south. From any point on this part of the coast access to the interior is easy. But this coast fronts the enclosed Irish Sea, not the open ocean, and in the absence of sufficient scouring its harbours all tend to become silted up. There are three harbours—Dundalk, Drogheda and Dublin, and the last is so much better than the others that it has always taken the lion's share of the trade. Ever since Ireland has been ruled from England, Dublin has been the natural seat of government, and has grown to be the largest town in Ireland.

Dublin, like London, is primarily a port and a governing centre; like it, it has naturally also become a University town and a place of miscellaneous manufactures. Chief among these are the brewing of stout and porter, and the distilling of whisky. There are also large chemical works. The most important export from Dublin is live stock, chiefly carried to Liverpool and Holyhead. There is a long approach to the harbour through Dublin Bay, and, to save time, steamers carrying mails and passengers run to the outport of **Kingstown**, on the south side of the bay, where a small artificial harbour has been made. Where the Leinster range comes down to the sea in the high promontory of Bray Head, in the pleasure-resort of **Bray**.

Dublin stands at the mouth of the Liffey, a short river which rises in the Wicklow mountains and takes a semicircular course to the sea. Its western watershed is low and indistinct, so that Dublin is in easy communication with the Boyne and Barrow basins, and on it, near Kildare, stands the military camp known as the **Curragh**, the country around which is famous for sheep. Farther north, on the borders of the Liffey and Boyne basins, the land is a rich grazing ground.

The Leinster range is a long and lofty mass of granite, and as it lies near and roughly parallel to the coast, the rivers on its eastern side are short and rapid. The granite of the Wicklow hills is largely quarried near Blessington and elsewhere, while the ancient rocks between it and the coast contain veins of metallic

ore, principally copper, the chief mines lying in the vale of Ovoca. A few small towns and fishing-ports lie at the mouth of these rivers, but when the mountain-range dies down and the longer rivers from its eastern side come down to the sea, long inlets of the sea are found running up their valleys—in fact there is a “drowned” type of coast-line. This extends along the whole south coast. The termination of the names Wexford and Waterford probably means “fiord” not ford, the names having been given by the Danes who settled there. Wexford harbour is silted up, and is replaced by an artificial harbour at **Rosslare**, from which steamers run to Fishguard in South Wales. The harbours that open southwards are deep and good, and each has a port, the two most important being **Cork** and **Waterford**.

Southern river system.—The geological map shows that here a number of parallel ridges of Old Red Sandstone alternate with vales of shaley rock. The rivers for the greater part of their length follow the latter, but at certain places turn at right angles to cross the former by gorges. Thus there is here a somewhat similar state of things to that seen in the Weald; but the ridges and vales are more numerous. The difference in the geology results in differences in the agriculture between this southern region and the central plain. The Suir basin, which has its outlet at Waterford, is the most fertile land for corn in Ireland; while the Cork district is largely devoted to dairy-farming. While both ports export much cattle, butter is one of the staples of Cork. There are bacon-curing factories at both places, and much bacon is exported. **Queenstown**, on an island in Cork harbour, is a port of call for American mail-steamers to and from Liverpool, the mails being carried by rail between Queenstown and Dublin, and thence by Kingstown and Holyhead to London and other places.

South-western coast.—West of Cork, the ports are small and mainly concerned in fisheries. The most important is the mackerel fishery of spring and autumn. The fishing grounds lie all along the west coast of Ireland; the boats land their fish at Kinsale or Valentia, where they are transferred to steamers

which take them to Milford Haven for despatch by rail to London or other English towns ; or else they are salted on the Irish coast, largely for export to America.

The appearance of this coast on the map resembles that of the west coast of Scotland, but examination of a large scale map with submarine contours shows that the long inlets here are not true fiords. They become deeper continuously seaward, without the shallowing near the mouth characteristic of fiords. Such inlets are known as *rias*, from the Spanish term for those on the west coast of Spain.

LESSON LVIII.

THE IRISH SEA.

1. On a general map of the British Isles measure the distance across the North Channel at the two points where it is least, stating in each case as exactly as you can from what points on each side your measurements are taken. Which of these would be the more convenient site for a railway tunnel between Scotland and Ireland, allowing for the importance of easy communication with large centres of population on each side? Measure the least distance across the English Channel and compare it with the above.

2. Measure the distances of the following steamboat routes :

Stranraer to Larne.	Holyhead to Kingstown.
Heysham to Belfast.	Fishguard to Rosslare.
Fleetwood to Belfast.	Fishguard to Waterford.
Liverpool to Dublin.	Fishguard to Cork.
Holyhead to Greenore.	Bristol to Cork.

Which of these routes are most suitable for the transport of mails, passengers and perishable goods ; and which for slower and cheaper traffic?

3. Measure the distance across St. George's Channel from the three points where Wales approaches most nearly to Ireland. There are only two direct steamboat routes across this channel, *viz.* Holyhead to Kingstown (or Dublin), and Fishguard to Rosslare. One of these agrees almost exactly with one of the

three shortest distances, while the other is 12 miles longer than it (apparently) need be, and there is no route corresponding to the third narrow part. What is the explanation of these facts?

4. Measure the least distances from the Isle of Man to each of the three kingdoms of England, Scotland and Ireland, stating in each case the points at each end of the line measured.

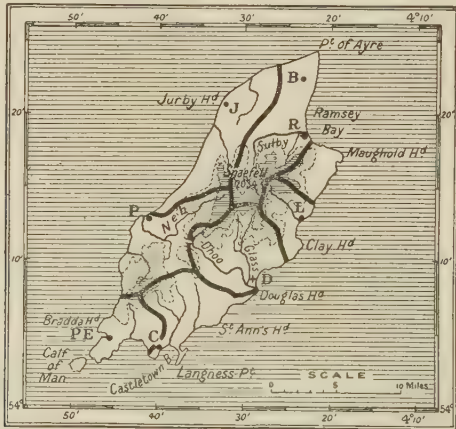


FIG. 97.—THE ISLE OF MAN.

Scale—10 miles to an inch. Contour-lines at 500 and 1000 feet above sea-level.

Measure the length, breadth and area of the Isle of Man (Fig. 97), of Anglesey (Fig. 61) and of the Isle of Wight (Fig. 31), and tabulate the results. Take care to notice the scale of each of these maps.

5. Examine the geological map. With what near portion of the three kingdoms does the Isle of Man agree geologically? State the nature of the agreement.

6. What is the easiest route across the central part of the Isle of Man from coast to coast? What towns stand at the two ends of this route?

7. With which division of the United Kingdom does the Isle of Man show most resemblances in the above figures?

What are its main differences from that division? With which other divisions does it more nearly agree in those respects?

AGRICULTURAL STATISTICS.

		Isle of Man.	England.	Wales.	Scotland.	Ireland.
Percentage of total area cultivated - - -		67	76	59	26	73
Percentage of cultivated area arable - - -		80	44	29	70	31
Percentage of arable devoted to	Wheat -	1	15	5	1	1
	Barley -	5	13	11	6	4
	Oats -	23	18	25	28	23
Number per 1000 acres of	Cattle -	163	156	157	63	228
	Sheep -	528	458	755	366	183

The Irish Sea is the name of the widest portion of the sea that separates Ireland from Great Britain. It is connected to the Atlantic by two narrower portions—northwards, by the narrow **North Channel** that separates Galloway from Ulster; southwards by the less narrow **St. George's Channel**, separating Wales from Leinster. Examination of the geological map shows that these varying breadths of sea correspond to differences in the geology of the adjacent coasts. Where the seas are narrow, the coasts are formed of ancient rocks; where broad, of Carboniferous Limestone and New Red Sandstone. That this is not merely a coincidence is shown by the fact that patches of Carboniferous limestone are found along the north coast of Wales and the south coast of Scotland, though they do not occur inland from those coasts. It may be objected that the ancient rocks of the Lake District do not cause a very great westward projection of the Cumbrian coast; but opposite this coast, and separated from it only by comparatively shallow water stands the Isle of Man, and this is composed mainly of ancient rocks, with a little Carboniferous Limestone at its southern end facing the Carboniferous

Limestone of Anglesey, and New Red Sandstone (buried under alluvium) at its northern end facing the New Red Sandstone of Solway Firth. An elevation of the sea-bottom of between 200 and 300 feet would convert the whole of the Irish Sea into land, except for one deep channel. The North Channel would remain nearly as wide as now, and would be continued with the same width in a line running south midway between the Isle of Man and Ireland, and on along the centre line of the present St. George's Channel: It is probable that the land thus added to the British Isles would consist, beneath the sea-sand and mud that now cover the sea-floor, mainly of Carboniferous Limestone and New Red Sandstone, and would connect the Irish Plain to the Cheshire Plain and Solway Plain, except for the deep channel just mentioned.

Isle of Man.—Thus the Isle of Man (Fig. 97) geographically belongs to Great Britain, not to Ireland, although in mere distance it is about equally near both. It probably also belongs rather to the Lake District than to the Southern Uplands. In one important respect it differs from the Lake District—owing to the lesser extent of high ground which it has, and to this lying mainly towards the eastern side, it has a lighter rainfall. Its soil is therefore cultivated to a greater extent, and the arable land especially forms a much higher proportion of the whole, though the rainfall is heavy enough to cause oats to be the chief corn-crop. As in the geologically-similar districts of Wales, Lakeland and the Southern Uplands sheep are largely pastured, and wool and woollen cloth are important products; and ores of lead, copper and zinc are mined and slates quarried. The combination of coast and mountain scenery attracts many holiday visitors in the summer.

Communications.—The Irish Sea and its two channels form, in one sense, a barrier between Great Britain and Ireland. In another sense, they serve as an easy means of communication between them. While ships from all parts of the world make their way along them to the ports of Liverpool and Manchester, in the heart of the busiest industrial region of Britain, there are also numerous vessels running across from Irish to British

ports. These cross-channel services fall roughly into two sets—the short and the long. As sea-transport is much cheaper than railway-transport, cheap goods, to the price of which the cost of carriage makes an important addition, are preferably sent by the routes which include least rail and most sea ; while valuable goods, perishable goods, mails and passengers to whom time is more important than expense, go by the short sea routes.

The chief of the latter are those from **Stranraer** to **Larne** (across the North Channel), and from **Holyhead** to **Kingstown** or **Dublin**, and **Fishguard** to **Rosslare** (across St. George's Channel). Examples of the longer services are those from Glasgow to Belfast, Liverpool to Dublin, and Bristol to Cork.

The possibility of linking the railways of Great Britain and Ireland by a submarine tunnel has often been suggested. The most practicable site for such a tunnel would be under the North Channel. The shortest route would be between Fair Head and the Mull of Kintyre, but this would only lead to the Highlands of Scotland—Glasgow could only be reached by a second tunnel or a very roundabout way. Longer, but much more convenient is a site near the present Larne-Stranraer steamboat route ; the length of this would be about equal to that of the abandoned tunnel between England and France under the Straits of Dover, but the engineering difficulties would be much greater. Further, this route, though useful for communication between Scotland and Ireland, would be very roundabout for a journey say from London to Dublin. A Holyhead-Dublin tunnel would be the best for position, but its length is too formidable. To any tunnel there is one very serious objection—the difference of gauge (*i.e.* the width between the rails) in the railways of the two islands : all the Irish lines would have to be altered for the full advantage of union to be attained.

SUPPLEMENTARY PRACTICAL EXERCISES.

Lessons I.-XVIII.

1. If you can only spend one week at the seaside during your next summer vacation, find out by reference to Whitaker's or other Almanack one that will give you spring tides and moonlit nights.

2. By reference to Fig. 4 find on what parts of the coast you can bathe at high spring tide (*a*) in the early afternoon, (*b*) before breakfast.

3. Locate the position on your map of England of the counties in the following table. Arranging each group in order from west to east, plot the statistics on squared paper. What relations do you notice between position of the county, rainfall and the relative cultivation of wheat and oats?

RAINFALL AND CORN.

	Average Rainfall.	Percentage of the Arable Land devoted to	
		Wheat.	Oats.
Cumberland - -	47	1	33
Lincoln - - -	25	17	12
Suffolk - - -	23	18	9
Yorkshire (East Riding)	27	15	20
Cambridge - - -	24	25	14
Carnarvon - - -	50	1	10
Hereford - - -	30	15	18
Warwick - - -	27	22	19
Cornwall - - -	45	6	18
Dorset - - -	35	12	19
Essex - - -	24	22	13
Wiltshire - - -	32	18	18

4. Follow the course of the Great Eastern Railway from London to Colchester (Fig. 10).

In estimating the course of the rail-level on a map on this scale, bear in mind the following considerations :

(1) Where the railway crosses a river it does so by a bridge which may be from 20 to 40 feet or more above the water : therefore if the ground rising on each side of the river quickly comes to a contour-line, it will not be far wrong to take the rail-level as at the level of that contour-line.

(2) Where the railway crosses high ground its summit-level will be in a cutting that may be as much as 50 feet deep, or in a tunnel when rail-level will be still farther below the surface-level. Although, therefore, the highest point on the ground traversed may be anything less than 100 feet above the nearest contour-line (if contour-lines are drawn at 100 feet intervals), it will not be far wrong to take rail-level as the level of the highest contour-line crossed.

(3) Any point which is not near any contour-line may be estimated as exactly half-altitude between the two between which it lies. Thus a place in the middle of the unshaded area may be estimated at 50 feet above sea-level. The error in these estimations can never exceed 50 feet, and is usually less.

Measure the distance along the railway in the four sections beginning and ending at London, Romford (Rf.), Brentwood (Br.), Chelmsford (Cf.) and Colchester (Co.). Estimate the approximate rail-level at each of these places, and calculate the average gradient in each section.

5. Find a route for a railway from London to Colchester never rising 100 feet above the sea, and not crossing estuaries below the bridge-points given above. How much longer would this be than the main G.E.R.?

6. Which of the three railways (M.R., G.N.R., G.E.R.) running northwards from London (Fig. 10) has the easiest (most nearly level) course?

7. What is a *ford*? In what sort of situation would you expect a town to be whose name ends in *ford*? Do the following places (Fig. 10) answer your expectations : Brentford (B.), Hertford (Hf.), Bishop's Stortford (B.S.), Stratford (S.), Romford (Rf.), Chelmsford (Cf.)? Which of these combine with the suffix *ford* the name of the river forded?

8. Examine the following table and find the main kind of fishery in the Thames estuary. Calculate from the appropriate column in the lower table the percentage of this fishery belonging

to each port, taking the nearest whole number to your quotient. Representing the whole annual value of this fishery by a circle of about 1 inch radius, divide it into sectors to represent the proportion of each port, as in Fig. 13, p. 31.

What kinds of fish reach the London market exclusively by rail?

RELATIVE VALUES OF DIFFERENT KINDS OF FISH LANDED.

	Fish Caught in Nets. ¹	Fish Caught by Trawl or Line. ²	Shell-fish. ³
On the whole east coast of England - - - - -	19 %	78 %	3 %
In the Thames estuary from Harwich to Whitstable, ex- clusive of London - - -	1 %	12 %	87 %
London (Billingsgate market) -	0 %	100 %	0 %

VALUE OF FISH LANDED IN THAMES ESTUARY.

Ports.	Fish Caught in Nets.	Fish Caught by Trawl or Line.	Shell-fish.
	£1000.	£1000.	£1000.
Harwich - - - - -	8	0	15
Brightlingsea - - -	1	1	9
Burnham-on-Crouch -	1	0	18
Southend - - - - -	1	0	2
Leigh - - - - -	3	1	14
London (Billingsgate) -	591	0	1
Queenborough - - -	4	0	9
Whitstable - - - - -	0	0	60

9. On an outline county-map of England, shade most darkly the counties producing over 500,000 tons of chalk; less heavily, those with from 10,000 to 500,000 tons; and lightly those with less than 10,000. Compare the shaded area with the outcrop of chalk shown on the geological map.

¹ Herrings, mackerel, pilchards, sprats.

² Round fish (cod, haddock, whiting, etc.) and flat-fish (sole, plaice, etc.).

³ Mainly oysters; also mussels, lobsters and crabs.

OUTPUT OF CHALK AND FLINT, 1907.

	Chalk.		Flint.		Chalk.		Flint.	
	1000 tons		1000 tons		1000 tons		1000 tons	
Bedford -	-	112	0	Middlesex -	-	44	0.3	
Berks -	-	5	0.4	Norfolk -	-	15	6	
Bucks -	-	0.3	0	Oxford -	-	1	0.5	
Cambs -	-	214	0	Somerset -	-	0.5	2 ¹	
Dorset -	-	0.7	0	Suffolk -	-	12	1	
Essex -	-	614	6	Surrey -	-	222	3	
Hants -	-	114	1	Sussex -	-	210	3	
Herts -	-	24	2	Wilts -	-	11	0	
Kent -	-	3034	17	York -	-	35	1	
Lincs -	-	78	0					

10. From the following statistics, make percentage diagrams to show (a) the proportion of the chief items to the total import trade of each port, (b) the same for the export trade, (c) the proportion of the herring export in these two ports to the whole of the kingdom.

TRADE OF YARMOUTH AND LOWESTOFT, 1907.

IMPORTS.				Yarmouth.	Lowestoft.
				£1000.	£1000.
Corn	-	-	-	52	—
Timber	-	-	-	204	75
Oil-seed cake	-	-	-	32	4
Stone	-	-	-	5	6
Manure (Phosphate)	-	-	-	4	—
Other articles	-	-	-	78	3
EXPORTS.					
Herrings	-	-	-	403	350
Other articles	-	-	-	21	2

Total Value of Herrings Exported from U.K. in 1905, £3,134,000.

"	"	"	"	Yarmouth	"	363,000.
"	"	"	"	Lowestoft	"	337,000.

¹ Including chert, not from chalk.

Lessons XIX.-XLV.

1. Make a list of the metal industries (*a*) which are found in Staffordshire and Warwickshire and not in Lancashire ; (*b*) which are of much greater importance in the former ; (*c*) which are of about equal importance in both ; (*d*) which are much less important in the former. What general character can you give as a description of the industries coming under (*a*)?

DETAILS OF METAL INDUSTRIES, 1901.

Metal Industries.	Lancashire.	Staffordshire and Warwickshire.	Yorkshire.
	Number of Thousands employed.	Number of Thousands employed.	Number of Thousands employed.
METAL-MAKING :			
Blast-furnaces - - - - -	1	1	4
Puddling-furnaces and rolling-mills - - - - -	4	19	8
Steel-smelting and founding - - - - -	2	2	13
Other metals than iron - - - - -	1	2	0
METAL-USING :			
Engineering and machine-making - - - - -	126	57	80
Tool-, file-, saw-, scissors-, needle, pin and steel-pen-making - - - - -	3	14	27
Type-, die- and coin-making - - - - -	0	2	0
Arms making - - - - -	0	4	0
Anchor- and chain-making - - - - -	0	3	0
Nail, bolt and screw-making - - - - -	2	9	1
Stove, grate and bedstead making - - - - -	1	5	2
Wire-making - - - - -	4	2	4
Tinplate goods making - - - - -	4	5	2
Working in other metals than iron - - - - -	0	42	3
Locks and keys, lamps, gas-fittings, etc. - - - - -	0	10	0
Vehicles(motor-cars, cycles, etc.) - - - - -	0	23	11
Watches, clocks and scientific instruments - - - - -	0	11	12
Precious metals and jewellery - - - - -	0	14	0
Other workers in iron - - - - -	0	5	0
	148	227	167

2. Make a sketch-map of the Black Country, shading ground over 500 feet above the sea, and marking by a dot each of the furnaces in blast in 1906—

Bilston (Bi.)	-	-	7	Old Hill (O.H.)	-	-	1
Dudley (Du.)	-	-	3	Brierley Hill (B.H.)	-	-	1
Tipton (T.)	-	-	3	Darlaston (D.)	-	-	1
Walsall (Ws.)	-	-	1	Birmingham (B.)	-	-	1
Wednesbury (W.)	-	-	1				

3. Measure the area of the North Staffordshire coalfield (Fig. 44). In which directions is there a possibility of it having an underground extension?

4. Measure the breadth of the "wind gaps" in the part of the Trent watershed shown on Fig. 44, where it descends below the 500-foot line. Which of these gaps is crossed by a railway without tunnelling, and which by means of a tunnel? What connexion can you trace between the breadth of the gap on the map and the method of taking a railway across it?

5. Measure the distance along the Avon from Bristol Docks to Avonmouth Docks (Fig. 53). Can you give any reason why docks should have been made at Bristol when Avonmouth is so much nearer the open sea?

6. Make a graph to show the variation in output and value of tin during the last third of a century. What does it show as to the changes in the price of a ton of tin?

OUTPUT AND VALUE OF TIN EVERY THIRD YEAR
FROM 1873 TO 1906.

	Output.	Value.
	Tons (to nearest hundred).	£1000
1873	14,900	1,057
1876	13,700	601
1879	14,700	587
1882	14,000	806
1885	14,400	662
1888	14,400	895
1891	14,500	735
1894	12,900	488
1897	7,100	254
1900	6,800	524
1903	7,400	532
1906	7,200	713

7. Does the North Staffordshire railway near Madeley (Ma., Fig. 44) cross *over* or *under* the London and North-Western railway? Give reasons for your answer.

8. The Great Western railway from Swindon to Bristol takes a practically straight course through Chippenham to Bath, and a second nearly straight course to Bristol. On this line lies the Box tunnel, over a mile in length: find from Fig. 51 the only part of the line where such a tunnel could be necessary.

Another line branches off from this one at Wootton Bassett and takes a nearly straight course to the Severn Tunnel: this also has a tunnel over a mile long, not under the main watershed. Find the most probable position for this, and see if the name of the nearest town is given to one of the tunnels in the list on p. 207.

Make a sketch-map of the two railways, indicating the position of the tunnels. Verify by reference to Bartholomew's *Touring Atlas*, or a large-scale railway map.

9. Make a series of percentage diagrams to illustrate the following statistics.

TRADE OF THE CHIEF SOUTH WALES COAL-PORTS.

	Newport.	Cardiff.	Swansea.
	£1000	£1000	£1000
IMPORTS, 1907 :			
Corn - - - -	0	2,000	443
Potatoes, etc. - -	52	167	57
Iron ore - - - -	592	875	38
Other ores and metals -	171	60	2,066
Iron and steel - -	548	64	146
Petroleum - - - -	0	57	0
Paper-making materials	0	134	0
Timber - - - -	468	1,439	247
Sugar - - - -	0	0	161
Othes goods - - -	49	726	184
Total - - - -	1,880	5,522	3,342
EXPORTS, 1907 :			
Coal, etc. - - - -	2,926	13,342	2,576
Copper - - - -	0	0	1,360
Iron and steel - - -	891	490	3,545
Other metals - - -	0	0	153
Other goods - - -	141	355	618
Total - - - -	3,958	14,187	8,252

10. Represent all the following statistics graphically, and state the general results in words, thus—"The percentage of land cultivated decreases, on the whole, as the rainfall increases," and so on.

WALES—AGRICULTURAL STATISTICS.

COUNTY (in order of cultivation).	Rainfall.	Percentage Cultivated of Total Area.	Percentage Arable of Total Cultivated.	Cattle per 1000 Acres.	Sheep per 1000 Acres.	Population per 1000 Acres.	Percentage Mountain and Heath.
Anglesey - - -	36	86	45	317	534	287	5.6
Pembroke - - -	42	79	32	240	363	224	10.2
Flint - - - -	30	78	35	240	588	497	6.7
Carmarthen - - -	54	75.5	20	208	489	211	11.1
Denbigh - - - -	45	63	37	165	875	309	19.7
Cardigan - - - -	45	60	38	157	609	138	32.2
Radnor - - - -	40	54	25	108	969	77	39.8
Montgomery - - -	60	54	28	142	904	108	32.0
Glamorgan - - -	51	52	20	115	679	1190	25.1
Carnarvon - - - -	65	47	31	152	756	338	35.7
Brecon - - - -	61	44	25	87	1112	115	44.7
Merioneth - - - -	65	36	20	90	1046	114	45.1
All Wales - - - -	—	59	29	157	755	—	27.1
England for comparison	—	76	44	156	458	—	7.3

Make a note of the most striking exceptions to regularity in your curves, and try to explain them. Thus—State the general relation of population to cultivation, make a list of the exceptional counties, and compare this with a list of counties in which much coal-mining and slate-quarrying are carried on.

11. Compare graphically the output of coal, iron-ore and fireclay in the following coalfields.

OUTPUT OF CHIEF ENGLISH COALFIELDS, 1906.

	South Wales.	North Wales.	North and South Staffs., Warwick and Leicester.	Lancashire and Cheshire.	Yorkshire and Derbyshire.	Durham and Northumber- land.
Coal (million tons) - -	47	3	21	25	60	52
Iron ore (1000 tons) - -	22	0	1018	0	55	0
Fireclay (1000 tons) - -	182	69	397	172	416	532

12. Measure the areas of the coalfields given in the table on p. 315, as shown on the geological map. Calculate the output of coal per 100 square miles in each case. What inaccuracy would there be in a comparison based on this calculation?

13. Make two percentage diagrams showing (a) the quantity and (b) the value of the slates produced in each division of the United Kingdom, and separately distinguishing the two counties with the largest production.

PRODUCTION OF SLATES, 1906.

	Quantity.	Value.
	1000 tons.	£1000
ENGLISH COUNTIES:		
Cornwall - - - - -	18	34
Lancaster - - - - -	21	52
Cumberland, Westmorland, Leicester, Devon and Somerset - - - - -	20	22
WELSH COUNTIES:		
Carnarvon - - - - -	250	725
Merioneth - - - - -	112	296
Cardigan, Carmarthen, Denbigh, Mont- gomery and Pembroke - - - - -	18	27
SCOTTISH COUNTIES:		
Argyll - - - - -	24	45
Dumbarton, Perth and Inverness - - -	7	14
IRISH COUNTIES:		
Cork, Kilkenny, Tipperary and Wexford -	6	15
ISLE OF MAN - - - - -	17	1
Total - - - - -	493	1231

By comparing the two diagrams, find which district produces the most valuable and which the least valuable slates. Verify your conclusion by calculating the average price per ton (a) for the United Kingdom, (b) for the two districts.

14. Make three diagrams for the three counties on p. 317 in which the percentage of the occupied population engaged in different industries is represented by sectors of a circle (cf. Fig. 13). Colour the sectors as follows—Agriculture green, Transport red, Textiles blue, Metals and Machinery yellow, Mines and Quarries black, all other occupations white (or use different kinds of shading in place of colours).

POPULATION, 1901.

Numbers engaged in	Cheshire.	Lancashire.	Shropshire.
	1000	1000	1000
Textile industries - -	56	524	2
Domestic service - -	52	175	18
Transport (railway, road and canal) - - -	35	198	7
Agriculture - - -	31	52	23
Metals and machinery -	30	181	8
Dress of all sorts - -	29	132	6
Supply of food, drinks, tobacco and lodging -	27	151	7
Building and construction	27	128	8
Mines and quarries - -	5	104	6
Commerce - - -	18	90	2
Professions - - -	14	65	4
All other occupations -	51	290	10
Total occupied - -	375	2090	101
Total population - -	594	3923	240
Area of county in 1000 ac.	643	1208	862

15. Make three diagrams like Fig. 12, to show density of population in Cheshire, Lancashire and Shropshire.

16. Make percentage-diagrams from the following tables. What important difference do you notice between the two tables? How do you account for it?

IMPORTS OF RAW COTTON, 1907.		EXPORTS OF COTTON GOODS, 1907.	
Port.	Value.	Port.	Value.
	£1,000,000		£1,000,000.
Liverpool - -	53 ¹	Liverpool - -	63
Manchester - -	13 ¹	Manchester - -	10
London - -	2 ²	London - -	8
Belfast - -	1 ²	Hull - -	5
Other ports - -	1	Glasgow - -	5
		Southampton -	4
		Grimsby - -	1
		Other ports - -	1
	70		97

¹ Mostly retained for manufacture.

² Mostly re-exported raw.

17. From a county-map of England, make a sketch-map of the counties on the following list. Calculate the density of population of each and indicate it by shading on your map, thus—less than 2 persons to 10 acres blank; between 2 and 4, light shading; between 4 and 10, medium; over 10 dark.

County.	Area. 1000 Acres.	Population, 1921. 1000.
Cumberland - -	973	273
Westmorland - -	505	66
Lancashire - -	1195	4928
Cheshire - - -	658	1025
Staffordshire - -	741	1349
Shropshire - - -	862	243
Denbigh - - -	426	155
Flint - - - -	164	106
Montgomery - -	510	51

18. Make also a series of diagrams representing density of population by means of the number of dots in a square inch.

19. Compare the Roman Wall with the Newcastle and Carlisle Railway. What circumstances led to so nearly the same site being chosen for both? Why should the Roman wall have been built on higher ground than the railway? Why on the rise towards the north rather than towards the south?

20. By reference to the table given under Exercise 1 (above) make a list of the metal-industries which are more important in Yorkshire than in either Lancashire or the Black Country. In what towns in Yorkshire are these industries respectively carried on?

21. How many miles is it by railway (Fig. 76) from Newcastle to Tynemouth? To Monkwearmouth? What is the compass-bearing of each of these towns from Newcastle? How many miles is it along the coast from the mouth of the Tyne to that of the Wear?

Lessons XLVI.—LIII.

1. Measure the approximate width of the Forth (Fig. 82) (*a*) at Culross (Cu.), (*b*) at the Forth Bridge, (*c*) from near Kirkcaldy (K.) to Leith (L.), (*d*) along the meridian of 3° W. long., and (*e*) from Elie (El.) to west of North Berwick (N.B.).

2. Illustrate the following table by a percentage diagram.

PRODUCTION OF OIL SHALE, 1907.

Counties.	Quantity.	Value.
	1000 tons.	£1000
Linlithgow - - -	1792	463
Edinburgh (Midlothian) -	733	189
Lanark - - - -	21	5
Flint - - - -	1	—
Sutherland - - -	—	—

3. Make a list of the towns in the Tay basin having more than 100,000, more than 10,000, and more than 5000 population respectively. Measure and tabulate the distance and direction of these from one another.

4. Illustrate by a graph the diminution in quantity and value and the change in value per cwt. of whalebone landed in Dundee.

IMPORTS OF WHALEBONE INTO DUNDEE, 1903-1907.

	1903.	1904.	1905.	1906.	1907.
Quantity (cwts.) -	142	132	332	35	—
Value (£1000) -	19	14	35	3	—

5. From the table below calculate the acreage of orchards per 1000 acres of cultivated land in each case given, and compare the results graphically with the values for all England (10) and Herefordshire (60).

ORCHARDS IN SCOTLAND.

Counties with more than one acre of orchard in 1000 of cultivated land.	Area in Thousands of Acres.		Areas in Acres.		
	Total Area.	Cultivated Area.	Total Orchard.	Apple Orchards.	Plum Orchards.
Lanarkshire -	563	256	795	149	126
Perthshire -	1596	337	608	369	73
Haddingtonshire	171	112	96	41	16
Stirlingshire -	289	116	130	50	14
All Scotland -	19,070	4866	2387	953	270

6. Measure the area of the Carse of Gowrie on Fig. 83 (between the Tay and the 500-foot contour-line), and express it in acres. Assuming that all this area is cultivated, and that it contains all

the orchards of Perthshire, calculate the acreage per 1000 given to orchards in the Carse of Gowrie, and compare it graphically with the other statistics just obtained.

In what ways are the two assumptions just made probably incorrect? Do the errors tend to correct one another or is their effect cumulative?

7. A market may have many sheep because it is convenient either for the area where they are reared, or for the area where they are killed and eaten. Divide the sheep-markets given below into three classes according as they are convenient in one or other or both these ways.

LARGEST SHEEP-MARKETS IN GREAT BRITAIN.

(The numbers are thousands of sheep in the markets in 1905.)

London, 447	Salford, 504	Glasgow, 330	Perth, 466
Liverpool, 340	Carlisle, 283	Edinburgh, 237	Stirling, 254

8. From the table on p. 268 construct percentage diagrams showing (*a*) the relative values of the different kinds of fish landed at Aberdeen (*b*), (*c*) and (*d*) the share of Aberdeen in the totals of net-fish, round fish and flat-fish landed in Scotland.

9. In 1905, 387,000 tons of fish were landed in Scotland; 163,000 tons were conveyed from the ports by rail to London and other distant or inland places. Assuming that the value per ton of the fish conveyed by rail was no higher than that left in the ports, find, by reference to the table on p. 268, the value of the latter. Compare this value graphically with the value of fish exported from Scotland (£2,169,000) and account for the difference.

10. Illustrate by percentage circles the share of the different Scottish ports in the two chief fish-curing industries shown below.

CURING AND SMOKING OF FISH, 1905.

	Herrings Cured.	Haddocks Smoked.
	1000 barrels	1000 cwt.
Orkney and Shetland	1087	—
Fraserburgh - -	249	2
Peterhead - - -	210	1
Wick - - -	162	1
Aberdeen - - -	87	324
Eyemouth - -	67	1
Other East coast ports	69	11
West coast ports -	181	—
Total - - -	2112	340

11. Measure, on a general map of Scotland, the length of Glen More, (*a*) its inland portion or Glen More proper from Inverness to Fort William, (*b*) the whole length of the straight line from Tarbat Ness to the mouth of Loch Linnhe.

12. Measure the length of the following inlets of the sea (Fig. 85): Loch Torridon, Loch Broom (both the narrow portion, and the total length from a line drawn at a tangent to the coast), Loch Eriboll, Kyle of Tongue, Dornoch Firth (from 4° W. long.), Cromarty Firth, Moray Firth (from a line drawn from Lossiemouth to Tarbat Ness, to Fortrose), Inverness Firth and Beaully Firth.

13. Notice the low pass between Loch Shin and Loch More (Fig. 85). What is its approximate altitude? Why has no railway been made across this pass, when the Strone Ferry line has been made across a higher pass? Refer to the map of Scotland in your Atlas to find an explanation.

14. Examine the general map of Scotland. How many railways reach the west coast? Why is it that no railways run for any great distance *along* the west coast, as they do along the east coast, the north coast of Wales, etc.? What would you expect to be the easiest way of getting from Oban to Strone Ferry?

Lessons LIV.—LVIII.

1. On an outline-map of Ireland, by reference to the Table on p. 285, shade the Ulster counties as follows—less than 2 acres of wheat per 1000, lightly; between 2 and 10 acres, more deeply; over 10, very deeply.

2. On another outline-map, or a sketch map, arrange the counties of Ulster in four groups, each group forming a compact geographical area:

- (*a*) with a relatively low acreage of both wheat and flax;
- (*b*) with a moderate acreage of both;
- (*c*) with the highest acreage of flax;
- (*d*) with the highest acreage of wheat.

Shade those counties that have a population of over 250 to 1000 acres, leaving those with less than 250 unshaded, and note how this distinction falls in with that previously made.

3. On an outline map of Ireland, shade the counties having the greatest density of sheep. Describe their distribution in words.

CHIEF SHEEP-REARING COUNTIES IN IRELAND.

Carlow, 376	Louth, 251	Westmeath, 275
Dublin, 296	Mayo, 233	Wexford, 270
Galway, 385	Meath, 377	Wicklow, 369
Kildare, 314	Roscommon, 282	

4. Calculate the following maxima and minima as percentages of the average, and express the relations in diagrams like Fig. 37.

COUNTIES WITH THE LEAST AND GREATEST NUMBER
PER 1000 ACRES OF

CATTLE	{ Meath, 362	SHEEP	{ Galway, 385
	{ (Average, Ireland), 228		{ (Average (Ireland), 183
	{ Galway, 135		{ Fermanagh, 19

5. Calculate the average value per ton of the slate raised in each of the districts given in the table below. State in a sentence how the best Irish slates compare with the best Welsh and Scotch slates, both in value and in quantity raised.

PRODUCTION OF SLATES IN IRELAND, 1906.

County.	Tons.	Value.
Cork - - -	1416	£2,579
Kilkenny - - -	425	1,275
Tipperary - - -	3261	11,400
Wexford - - -	460	112
For Comparison—		
Carnarvon and Denbigh	254,688	739,632
Merioneth - - -	112,206	295,502
Scotland (mainly Argyll)	30,812	59,819

6. From a consideration of the several columns of the following table, state what you consider to be the most *important* mineral products of the Isle of Man, giving your reasons.

CHIEF MINERAL PRODUCTS OF THE ISLE OF MAN, 1906.

Mineral.	Quantity.	Percentage of U.K. by Quantity.	Value.	Percentage of U.K. by Value.
	1000 tons		£1000	
Slate - - -	17	3.5	1	less than 0.01
Igneous rocks -	11	0.2	1.5	" "
Clay - - -	7	0.05	1	" "
Limestone -	5	0.04	1	" "
Brine salt -	4.5	0.3	3	0.5
Lead ore -	2.5	8.0	31	9
Zinc ore -	2.5	10.5	15	10.5

EXAMINATION QUESTIONS.

The following questions are selected from the papers in Geography set in recent years at the Oxford and Cambridge Local Examinations, the University of London Matriculation Examination, and the Examinations of the College of Preceptors. The author is indebted to the authorities of the respective Universities and College for kind permission to reprint them. In a few cases the questions have been altered by the omission of portions not relating to the British Isles.

Questions on Lessons I.-XVIII.

1. Draw a Map of the North Sea, from the Straits of Dover to the most northern parts of Scotland and Denmark. Insert, with names, the Dogger Bank, the chief ports, and the chief river mouths. Show by figures the various depths of the sea.

(C.P.)

2. Draw a rough sketch-map of England and Wales, indicating which parts are hilly and which are not.

(Oxf. Prel.)

3. Explain generally how tides are formed and why some are higher than others. Draw an Outline Map of Great Britain, and insert the co-tidal lines.

(C.P.)

4. How are the tides caused? Describe the tidal phenomena off the east coast of England and in the Irish Sea.

(London Matric.)

5. On January 1 high-water occurred at the following places at the times stated:—London Bridge, 3.20 a.m.; Bristol, 8.43 a.m.; Dublin, 12.14 a.m.; Liverpool, 12.35 a.m.; Greenock, 1.31 a.m.; Leith, 3.52 a.m.; Hull, 7.53 a.m. Explain why, in places which are so near one another, there should be such great differences in the time of high-water.

(Camb. Sen.)

6. On the accompanying maps of the British Isles the average isotherms for the months of January and July are drawn. Explain the differences between the form and direction of the isotherms in the two maps.

(Camb. Sen.)

7. On what parts of the coasts of the British Isles would you expect to find (a) a mild climate in winter, (b) a cool climate in summer? Give reasons for your answers.

(Camb. Sen.)

8. Describe the average distribution of temperature in Great Britain during the winter months, pointing out how it differs from the distribution during the summer. Account for the facts.

(Oxf. H.L.)

9. What is meant by *isothermal lines*? Why do they vary in their direction at different seasons of the year? Illustrate your answer by a particular example. (C.P.)

10. What part of the British Isles has the highest average temperature and what part has the lowest (*a*) in January, (*b*) in July? In each case give a reason. (Camb. Sen.)

11. Which are the least rainy parts of the British Isles, and why? (Oxf. H.L.)

12. Give some account of the climate of the British Isles, pointing out the effects of the physical configuration of the country, the prevailing winds, and the surrounding waters.

The mean annual rainfall at Harwich is about 23 inches, and at Belmullet, on the west coast of Mayo, about 50 inches. How do you account for this difference? (Oxf. Jun.)

13. Compared with central England, the climate of Cornwall is noted for (*a*) cool summers and mild winters, and (*b*) abundant rainfall. How do you account for these facts? (Oxf. Prel.)

14. At three places in England the sun rises at the clock-times undermentioned:

	A	Greenwich	C
on 20th March	6.29	6.7	6.15
on 21st June	4.18	3.45	3.29

State how A and C lie with respect to Greenwich in latitude and longitude, and give the direction, if you cannot give the amount, of difference. (Camb. Jun.)

15. Explain the course of the tidal wave around the British Isles. Explain any peculiarities in the tides of different parts of the British coasts. (London Matric.)

16. Describe briefly the passage of the tidal wave round the British coasts, and explain the conditions which prevail (*a*) at Southampton, (*b*) in the Thames estuary, (*c*) in the Pentland Firth. (Oxf. H.L.)

17. Give an account of the sources from which London obtains its water-supply. Mention instances showing that the sites of villages or towns have been determined by water-supply. (London Matric.)

18. The London Basin is surrounded by a wall of chalk, except to the east.

Draw a sketch-map showing the position of this 'wall.' Name its chief divisions. Show the 'gaps' traversed by the main lines of the Great Western and London and North-Western railways. (Oxf. Sen.)

19. Draw a map to show the course of the Thames and its chief tributaries, and the ranges of hills within or bordering its basin, and show clearly the relationship of the rivers to the lines of hills. Insert and name four towns at gaps in these hills. (Oxf. H.L.)

20. Describe the course of the Thames from its source to its mouth, mentioning its chief tributaries and giving the names of the counties through which it flows and of the chief towns on its banks. (Oxf. Jun.)

21. Draw a map of the Thames and its tributaries, below Reading and above Gravesend. Show the North Downs and the Chiltern Hills. Mark the position and name a town at each gap where a river crosses the North Downs.

(London Univ. School Exam.)

22. Describe the configuration (land-relief) and river-system of the Weald, and point out how the two are adjusted to each other.

(London Matric.)

23. Describe a railway journey from London to Brighton. On that journey state whereabouts you would expect to meet with deep cuttings and long tunnels. What kind of rocks do you think you would pass through in those parts? (London Matric.)

24. Write a description of the physical features of the part of the island shown on the accompanying map east of long. $1^{\circ} 20'$. [Map of Isle of Wight provided.] Draw a section to scale from Osborne Pier to the shore south of St. Lawrence station. The contour-lines are at intervals of 100 feet. (London Matric.)

25. Name four large towns (excluding London) which lie to the east of a line drawn from King's Lynn to Weymouth. Describe the position of each, and mention the causes which have favoured its growth. How do you account for there being so few large towns in this part of the country? (Camb. Jun.)

26. The best wheat-growing region in England is in the eastern counties. Give the names of these counties, and describe their position. State any reasons why they are specially suitable for producing wheat. (Oxf. Prel.)

27. Trace the course of the oolitic line of hills across England; and name and indicate precisely the positions of three of the largest towns situated anywhere to the south and east of this line, stating to what special advantages each of them owes its importance. (Camb. Sen.)

Lessons XIX.-XLV.

1. Where is the so-called Black Country? What is the origin of the name? Give the names of towns situated in it? What are its chief industries? (Oxf. Prel.)

2. Describe the positions of the chief English coalfields which are *not* near the coast. To what special uses is the coal obtained from them put? (Oxf. Jun.)

3. Describe the basin of the Severn, pointing out the course of the main stream, the chief tributaries, and the nature of the country through which they flow. (London Matric.)

4. Describe briefly the course of the river Severn and of the rivers flowing into its basin. Name and give the positions of five important towns on their banks, stating any circumstances for which they are noted. (Camb. Jun.)

5. Name in order *four* important headlands and *three* important sea-side resorts which would be passed in a coasting voyage from Plymouth to Dover. (Camb. Jun.)

6. Describe **either** (a) a coasting voyage from Plymouth to London, **or** (b) one railway route from Plymouth to London. (Camb. Sen.)

7. Name four important ports on the south coast of England; describe their positions and state in what way each of them is important. (Camb. Prel.)

8. Describe carefully, or show by a sketch-map, the relative positions of Exmoor, Dartmoor, the Plain of Devon, the Vale of Taunton, and the Plain of Somerset. Apply your answer to account for the routes followed by the two main lines of railway connecting Plymouth with the East of England. (Oxf. H.L.)

9. Write a short description of the Devon and Cornwall peninsula, pointing out the main features of its outline, surface-relief, drainage, and climate. What are its most important agricultural and mineral products? (Oxf. Jun.)

10. What are the chief industries of Cornwall? (Oxf. Prel.)

11. Describe the position of the South Wales coalfield. Explain why large quantities of Welsh coal are exported to foreign countries, and name the seaports from which most of it is shipped. (Oxf. Prel.)

12. In what part of Wales is the densest population to be found, and what are the circumstances to which this exceptional density is due? (London Matric.)

13. Divide Wales and the adjoining part of England west of the River Severn into natural regions. Describe the characteristics of each region, and show how they influence the distribution and occupations of the inhabitants. (London Matric.)

14. Draw a sketch-map of the coast between Carnarvon and Birkenhead, and of the rivers which flow into the sea on that coast. Name the rivers. Indicate on your map the higher parts of the

country (*e.g.* those which have an elevation of over 1500 feet). Compare the course of the English River Dee with that of the River Severn. (London Matric.)

15. Draw on a separate sheet of paper, and on as large a scale as your paper will allow, a sketch map of Wales. Also include in the map and name the English counties which adjoin it. Insert the county towns of these English counties, and in Wales name and mark two river mouths, two bays, three mountain peaks, and three important towns. (Camb. Jun.)

16. Give the positions of the following and state what you know about them: (*a*) Anglesea, (*b*) Dartmoor, (*c*) the Fens, (*d*) the Wrekin. (Camb. Prel.)

17. Show how the physical features of Wales controlled the progress of the English conquest in the twelfth and thirteen centuries. (Oxf. H.L.)

18. What inferences do you draw from the following table?

Counties.	Pembroke and Carmarthen.	Essex.
Area 1000 acres - - - -	980	980
Corn crops 1000 acres - -	96	294
Permanent pasture 1000 acres -	557	278
Mountain and Heath 1000 acres -	97	3
Cattle 1000 - - - -	204	84
Sheep 1000 - - - -	425	235
People 1000 - - - -	224	1084

(Oxf. H.L.)

19. Give some account of the surface configuration and river system of Wales, and show how they influence the distribution of population. (Oxf. H.L.)

20. Draw a sketch-map of Wales, inserting the names of three seaport towns and two inland towns. Show by shading which part of the country has the densest population. (Oxf. Prel.)

21. Discuss the considerations which have determined the sites of towns, using the following as illustrations: Lincoln, Cardiff. (Oxf. Sen.)

22. Draw a map of the part of Great Britain lying to the west of the Dee and Severn, inserting the chief mountains and rivers and ten leading towns, and marking the districts noted for (*a*) slate and (*b*) coal. (Oxf. Jun.)

23. Describe the nature and extent of the exports and imports of Liverpool. What are the conditions which have determined the character of the commerce of that city? (C.P.)

24. Compare the import and export trades of London and Liverpool, and discuss the extent to which geographical reasons account for the facts. (Oxf. H.L.)

25. There are said to be more people within 35 miles of Manchester than within that distance of any other city in Britain. How would you explain this? What industries support this population and how are these industries distributed? (Oxf. H.L.)

26. Write an account of the configuration, river-system and vegetation of the Pennine Chain and the country to the east of it between the Tyne and the Humber. (London Matric.)

27. Draw a map of England north of the Humber, showing and naming the chief ranges of hills and mountains and principal rivers. Indicate by dotted lines the three chief railway routes from England to Scotland and two of those crossing the country from west to east. (London Matric.)

28. Indicate the position, and name the chief industry, of each of the following towns, explaining why the industry has arisen where it is carried on: Barrow, Bradford, Chatham, Coventry, Llanberis, Nantwich, Northampton, Southampton, Swansea. (Camb. Jun.)

29. Describe shortly the courses of the chief rivers in the Humber Basin. Name and give the position of six important towns situated on these rivers, stating the circumstances, historic or other, which render these towns remarkable. (Camb. Jun.)

30. Describe the form and position of the 'Pennine Chain,' with special reference to the fact that it is not a range of mountains. Explain carefully its relation to the Cheviot Hills and the 'Lake District.' (Oxf. Sen.)

31. In what part of England does the nature of the physical features present the greatest obstacles to communication between populous districts? Name and state the position of four towns, two on one side and two on the other of the obstruction you mention. (London Matric.)

32. What are the chief industries of the counties of (1) Durham, (2) Cornwall? Name one town connected with each industry. (Camb. Prel.)

33. Place in order, in respect of the annual amount of rainfall, the following three towns: Liverpool, Manchester, York. (The town with the highest rainfall to come first.) State as fully as you can your reasons for placing the towns as you do. (London Matric.)

34. Give the positions of the ports on the west coast of England and Wales, from north to south, and account for their growth or decline. (Camb. Sen.)

35. In what counties are the following towns situated, and what industries are associated with each: Manchester, Sheffield, Droitwich, Coventry? (Oxf. Prel.)

36. Give the name of the chief port at the mouth of each of the following rivers: (a) Tyne, (b) Usk, (c) Tamar, (d) Mersey, (e) Wear, (f) Severn. (Oxf. Prel.)

37. Give the position and extent of two of the most important English coalfields, name two towns situated in each of these districts, and mention their special industries. (Camb. Jun.)

38. Discuss, historically and geographically, the boundaries of the six northern counties of England, and explain the position of the county town of each. (Oxf. H.L.)

39. Indicate the position and name the chief industry of the following towns, explaining why each industry has arisen where it is carried on: Bolton, Grimsby, Huddersfield, Stoke, Middlesbrough, Wolverhampton. (Camb. Jun.)

40. Give the positions of the following and state what you know about them: (1) Portland Island, (2) Spithead, (3) the Peak, (4) Windermere. (Camb. Prel.)

41. Draw on a separate sheet of paper, and on as large a scale as your paper will allow, a sketch map of that part of England which lies south of a line joining Bristol with London. Show the points on the coast line which mark divisions between counties, naming the counties. Name also and indicate the positions of two bays, three headlands, and five towns, included in the area covered by this map. (Camb. Jun.)

42. Draw a sketch-map showing the coast-line from Solway Firth to Gloucester: insert towns (*one* in each case) on or near the coast which are engaged in the following industries:—copper-smelting, building of war-ships, cotton-spinning, slate-quarrying, export of steam-coal: put the name of the industry beneath the name of the town to which it belongs. Also mark the course of the Severn, and the position of the Severn tunnel. [The map should be on a separate sheet of paper, and should fill most of the sheet.] (Camb. Jun.)

43. By what railway can a traveller go from London to Liverpool? Mention the principal towns which he would pass on the way. (Oxf. Prel.)

44. What are the chief towns passed in travelling from London to Chester by the G.W.R.? What coalfield is traversed and what chief rivers are crossed? (Oxf. Jun.)

45. Point out the chief regions of dense population in England, and in each case show the chief causes to which the density is due. (London Matric.)

46. Describe the conformation of the highlands of England which divide the rivers flowing into the Eastern, Southern, and Western seas. (Oxf. Jun.)

47. Describe the position of the coalfields of Great Britain south of Lancashire and Yorkshire, and in the case of each coalfield point out the chief uses to which its produce is put. (Oxf. H.L.)

48. Describe the positions of Dorset, Merionethshire, and Essex, naming the counties which touch them. Name the chief town of each of these three counties. (Camb. Jun.)

49. Compare the scenery of the central and eastern parts of England with that of the west (including Wales) and explain the reason of the difference. (Camb. Sen.)

50. The watershed of England has been said to have the form of an inverted T. Justify this statement, and mention some of the chief rivers of each of the three slopes. (Oxf. Sen.)

51. Make a sketch-map showing *either* the course of the Thames, its chief tributaries, and the more important towns on its banks, *or* the London and North-Western Railway with its chief branch lines and the chief towns through which it passes. (Oxf. Sen.)

52. Certain districts in central England are remarkable for the number of villages scattered over their surface, while in other districts villages are comparatively few. Give examples of such districts, and account for the difference. (Oxf. H.L.)

53. Explain the historical importance of :

(a) The estuaries of the Thames and Severn.

(b) The coal and iron fields of England. (Oxf. Jun.)

54. By means of examples discuss and explain the causes which have given rise to the different types of boundaries of English counties. (London Matric.)

55. Draw a map of Great Britain between the latitudes of Hull and Bristol, showing and naming the chief mountain-ranges and passes, the principal rivers and the coalfields. Indicate by dotted lines the routes taken by three of the main railway lines. (London Matric.)

56. By what railway lines would you make the following journeys: (a) London to Crewe; (b) Exeter to Oxford; (c) York to Berwick? (Oxf. Prel.)

57. Describe the result of submerging England and Wales to a depth of 600 feet. (Oxf. H.L.)

Lessons XLVI.-LIII.

1. What are the chief obstacles to railway communication between London and Edinburgh? Which of the three main lines has encountered most of these obstacles, and which has avoided most of them? (London Matric.)

2. Describe and account for the distribution of population in the region between the Clyde-Forth in the north, and the Solway-Tyne in the south. (Oxf. H.L.)

3. What part of Scotland is most densely populated? Mention any causes which make most of the people live in this part. Name some of the most populous counties. (Oxf. Prel.)

4. Where are the chief coalfields of Scotland and what important towns are situated upon them? (Oxf. Prel.)

5. Describe the course of the Clyde from its source to the end of the Firth, as far as Ailsa Craig. Name the counties, the islands, and any points of interest it passes, and give the names of six of the most important towns on or near its banks, stating for what each is noted. (Camb. Jun.)

6. Draw on a separate sheet of paper, and on as large a scale as your paper will allow, a sketch-map of the mainland of the part of Great Britain from the mouth of the Clyde to the Solway Firth, and from the south shore of the Firth of Forth to the mouth of the Tyne. Mark by means of alternate dots and dashes (. — . — . —) the boundary between England and Scotland. Name Luce Bay, the Mull of Galloway, Loch Ryan, St. Abb's Head, Wigtown Bay, and insert and name the rivers Clyde, Nith, Tweed, and Tyne, and the towns of Ayr, Berwick, Dumfries, Dunbar, Edinburgh, Glasgow, Kilmarnock, and Newcastle. (Camb. Jun.)

7. Make a sketch-map of England and the South of Scotland as far as to the Forth. On this map mark the mountain ranges (or groups) and the great railway lines from London to Edinburgh and Glasgow. What causes have determined the courses of these lines? (Scotch Leaving Certif. Exam.)

8. Draw a sketch-map showing the position of the line of hills which lies to the south of Strathmore. Indicate the chief divisions of this line, and gaps between them. Mark the rivers passing through these gaps, and the towns situated near them. (Oxf. H.L.)

9. Point out the historical importance of the Cheviot Hills and the position of Stirling. (Oxf. Sen.)

10. Give some account of the chief raw materials imported into Scotland for manufacture, stating what they are, whence they are imported, and where they are manufactured. (Oxf. H.L.)

11. Draw a map of Great Britain between the latitudes of the Tyne and the Firth of Tay. Show and name the chief mountain-ranges and passes, principal rivers and coalfields. Indicate by dotted lines the course taken by three of the main railway lines from London to the North. (London Matric.)

12. What is the distribution of population between the Clyde-Tay and Solway-Tyne estuaries? What geographical conditions suggest explanations? (London Matric.)

13. Describe briefly the courses of *three* of the principal rivers of Scotland. Mention one town on each. (Camb. Jun.)

14. Describe accurately the positions of Oban and Dumfries, and explain the conditions which make these towns important. (Oxf. H.L.)

15. Describe the chief routes from the Lowlands across the Highlands of Scotland as far as Glen More, and point out how they have been affected by the topographical features. (Oxf. H.L.)

16. Trace the route of a railway journey from Berwick-on-Tweed to Inverness. (Oxf. Prel.)

17. What are the chief differences between the physical features of the East and West Coasts of Scotland? (Camb. Prel.)

18. Contrast the East and West of Scotland in respect of configuration, climate and natural resources. (Scotch Leaving Certificate Exam., Jun.)

19. State which side of Great Britain has the higher and which the lower rainfall. Explain the difference and point out any influence which it has on the agricultural or manufacturing industries of the country. (Camb. Jun.)

20. Describe the characteristics of the fiords of the west coast of Scotland both above and below sea-level, and as far as you can explain their peculiarities. (Oxf. H.L.)

21. Name in order from North to South the Firths on the East coast of Scotland. (Camb. Prel.)

22. Describe the positions of (*a*) the Outer Hebrides and (*b*) the Orkney islands. Name some of the chief islands in each group, and the most important town in each group. (Oxf. Prel.)

23. Describe concisely the principal physical features of Scotland and show their relation to the industries carried on in different parts of the country. (Camb. Sen.)

24. How is it that—

(*a*) So many people go to Scotland for their holidays?

(*b*) Glasgow is so great a town? (C.P.)

25. What industries are carried on at the following places : Birmingham, Crewe, Dudley, Greenock, Kidderminster, Kilmarnock, Luton, Manchester, Nottingham, Paisley.

(Camb. Prel.)

26. Name two important towns on the East coast of Scotland, and two on the East coast of England ; state in what way each of the four is important.

(Camb. Prel.)

27. Give the positions of the following and state what you know about them : (a) Sheppey, (b) the Pentland Firth, (c) the Solent, (d) the Trossachs.

(Camb. Prel.)

28. Draw on a separate sheet of paper, and on as large a scale as your paper will allow, a sketch map of the east coast of Great Britain from the south shore of the Firth of Forth to the north bank of the Tees. Name the counties in order ; also name and mark the positions of three river mouths and five towns between the specified limits. State the latitudes of these limits.

(Camb. Jun.)

29. Describe the general distribution of Highlands and Lowlands in Scotland. What part of the country is most densely populated, and why ?

(C.P.)

30. How is it that the west coast of Scotland is more irregular than the east coast ?

(C.P.)

Lessons LIV.-LVIII.

1. State the relative position of the provinces of Ireland and the situation of the chief town in each. How far do these provinces and chief towns agree with those which existed before the English occupation ?

(Oxf. H.L.)

2. Irish time is about 25 minutes slow by standard time in Great Britain. Explain fully the meaning of this statement.

(Oxf. Jun.)

3. More than three-quarters of the surface of Scotland is practically waste land, while less than one-quarter of Ireland is unproductive. How do you account for the difference.

(Oxf. Jun.)

4. Contrast the physical configuration and natural resources of Scotland with those of Ireland, and show how the development of each country has been affected thereby.

(Scotch H. & L.)

5. Contrast the climatic conditions on the two sides of the Irish Sea, and explain the differences. Point out the chief geographical causes which have influenced the nature of the occupations pursued east and west of that sea.

(London Matric.)

6. Draw a sketch-map of the North of Ireland showing the counties of Down, Antrim, Londonderry, Donegal, and Tyrone. Mark Lough Foyle and Strangford Lough, and insert in their proper places Belfast, Londonderry, and Coleraine.

(Oxf. Prel.)

7. Give a geographical account of Ulster, describing its physical features and climate, and naming its chief industries and towns.

(Camb. Sen.)

8. Describe the distribution of the chief linen manufacturing districts of Britain. Point out how historical and geographical considerations account for this distribution.

(Oxf. H.L.)

9. Describe the basin of the river Shannon, illustrating your answer by a sketch-map. Point out specially the conditions which are favourable or unfavourable to inland navigation.

(Oxf. H.L.)

10. Trace the route of a trip down the Shannon from Lough Allen to the sea.

(Oxf. Prel.)

11. Compare the course of the river Severn with that of the river Shannon.

(Oxf. Jun.)

12. The south-east of Ireland is the most fertile part of that country, and it contains a number of fairly large inland towns. Discuss this.

(Oxf. H.L.)

13. Name the leading rural and other industries of Ireland, and the parts of the country in which they are chiefly localised; and discuss the climatic and other causes to which their being thus localised is to be attributed.

(Camb. Sen.)

14. Draw on a separate sheet of paper a sketch-map of the east coast of Ireland from Fair Head to Wicklow Head. Name the counties and mark the divisions between them; also name the river-mouths, inlets, and towns between the two limits named. Give the latitudes of these limits.

(Camb. Jun.)

15. Describe the character of the country passed in cycle rides from Dublin to (a) Killarney, (b) Sligo, (c) Belfast.

(Camb. Sen.)

GENERAL QUESTIONS.

1. Describe and compare the geographical situations and resources of the following pairs of towns (*a*) Barrow and Newcastle-on-Tyne, (*b*) Birmingham and Lincoln, (*c*) Belfast and Cork.

(London Matric.)

2. Describe the position of the following towns and point out the facilities possessed by each for carrying on its industries: Aberdeen, Cardiff, Crewe, Reading, Waterford, Wigan.

(London Matric.)

3. Describe and compare the geographical situations of the following pairs of towns: Bristol and Hull, Galway and Milford.

(London Matric.)

4. Give a brief account of the Cotswolds, the English Lake District, the Giant's Causeway, Glenmore and the Plain of York. In each case state the situation.

(London Matric.)

5. Take examples from the United Kingdom to show the relationships existing between the position of large towns and (*a*) water supply, (*b*) mineral resources, (*c*) vegetable products and (*d*) transport routes.

(London Matric.)

6. Draw a sketch-map of the Irish Sea. Mark and name (*a*) the mouths of the chief rivers, (*b*) the ports with a regular cross-channel service.

(London Matric.)

7. Describe the positions of the following places and explain how their commercial importance has been affected thereby: Sunderland, Belfast, Cardiff, Hull, Aberdeen.

(Oxf. Jun.)

8. Where in Britain are the following industries carried on: cotton manufacturing, slate mining, cod fishing, flax growing, and agricultural implement making? In each case give, if you can, any special reason why the particular industry should have sprung up just where it has.

(C.P.)

9. Does more rain fall on the eastern or on the western slopes of the Pennines? Can you explain why? What difference, if any, does this make to the kinds of work done on the eastern and on the western sides of the Pennines?

(C.P.)

10. Why is *corn* largely grown in the Eastern and South-eastern counties of England, and *grazing* extensively practised in Ireland? Which are the "*orchard* counties," and where is the "*Carse o' Gowrie*"?

(C.P.)

11. State the situation of *four* of the following towns: Barrow in Furness, Burslem, Cork, Dundee, Grimsby, Harwich, Waterford, Wolverhampton. Point out the circumstances that have determined the nature of the trade or leading manufacturing industry of each of the places which you select. (Camb. Jun.)

12. Give a brief description of the Bog of Allen, Dartmoor, Glen More and Salisbury Plain. In each case state the situation. (Camb. Jun.)

13. In what parts of Great Britain are the following chiefly found: (a) anthracite coal, (b) granite, (c) tin? And in what parts are people occupied in the following industries: (d) hop-growing, (e) the jute manufacture? (C.P.)

14. Describe and as far as you can explain the courses of the following rivers: (a) the Shannon from Lough Derg to its estuary, (b) the Bristol Avon, (c) the East Yorkshire Derwent, (d) the Nith. (Oxf. H.L.)

15. For each of the following articles name **one** town in Great Britain where it is manufactured: Glass, Silk, Hardware, Jute. What are Hardware and Jute? (Camb. Jun.)

16. Give a brief account of the Bog of Allen, the Chiltern Hills, Dartmoor, the English Fen district and Strathmore. In each case state the situation. (London Matric.)

17. Give a brief account of the Pennine Chain, the Weald, Salisbury Plain, the Central Valley of Scotland. (London Matric.)

18. Where are *any five* (not more) of the following towns, and for what is each of the five noted?—Cardiff, Barnstaple, Limerick, Coventry, Middlesbro', Oban, Waterford, Stornoway. (C.P.)

19. Where in the United Kingdom are the following industries carried on?—Linen-weaving, apple-growing, battleship-building, china-making, and cotton-importing. In each case give, if you can, reasons why the particular industry is in the particular place. (C.P.)

20. What and where are *Land's End*, *Dungeness*, *Shannon Estuary*, *Ouse Watershed*, *Bristol Channel*? Explain the words *italicised*. (C.P.)

21. What districts in the British Isles are famous for sheep farming, wheat and hop growing, slate mining, and ship-building? Name and locate any towns specially connected with these industries. (C.P.)

22. From what parts of the United Kingdom do we chiefly obtain *salmon*, *herrings*, *pilchards*, *linen*, *earthenware*, *salt*, *granite*, and *lead*? (C.P.)

23. 'Almost the whole foreign trade of Great Britain is carried on in four inlets on the East coast, three on the West, and one on the South.' Name the ports referred to in this statement and the chief trade of each. (Oxf. Jun.)

24. What do you know about the following : the Caledonian Canal, the Menai Straits, the Wash, the Goodwin Sands? (C.P.)

25. Distinguish between pastoral and agricultural land. State and explain the distribution of each of these in the region drained to the North Sea between the Forth and the Wash. (Oxf. H.L.)

26. Give an account of and, as far as you can, explain the physical characteristics of the west coast of Scotland, and compare it with the west coast of Ireland. (London Matric.)

27. Describe the position of ~~five~~ of the following towns and the circumstances to which each of the five owes its importance : Cardiff, Coventry, Dundee, Hanley, Macclesfield, Portsmouth, Welshpool.

What is a bore? Give an example from the British Isles. (Camb. Sen.)

INDEX TO PLACE-NAME ABBREVIATIONS ON THE MAPS.

The numbers are those of the Figures. Where the same abbreviation is used more than once in the same Figure, the position of each place to which it refers is distinguished by a note in square brackets.

- A.**—Aldershot 20, 21, 31; Axminster 25, 51, 57; Aldeburgh 36; Atherstone 42; Altrincham 43, 63 [N. part], 64-74 [S. of Mersey]; Audley, 44; Abergavenny 48, 59, 60 [on Usk], 63 [do.]; Aberystwith 60 [on coast], 61; Abercarne 60 [on Ebbw], 63 [do.]; Accrington 64-74 [S. of Ribble]; Allendale 69-75 [S. of Tyne]; Annan 73 [on Solway Firth]; Ayr 77, 80 [W. coast]; Ardrishaig 80 [inland]; Airdrie 82; Aberdeen 84; Antrim 88; Ardee 92.
- Ab.**—Abingdon 20; Aberystwith 48; Ashburton 57; Port Talbot or Aberavon 59, 60 [Swansea Bay]; Aberayron 60 [Cardigan Bay]; Ashbourne 73.
- Ad.**—Aberdare 59, 60; Aberdovey 61; Ardrossan 77, 80.
- Af.**—Alfreton 43, 73, 74; Alford 45; Aberfoyle 80, 82.
- A. in M.**—Ashton-in-Makerfield.
- Ak.**—Askam.
- A.L.**—Ashton-under-Lyme.
- Al.**—Alton 20, 21; Alsager 44; Audlem 63-73; Alston 77; Alloa 80, 82; Alness 84, 85.
- A.M.**—Aston Manor.
- Am.**—Amesbury 51; Amlwch 61; Ambleside 73.
- An.**—Andover 20, 31; Annan 77; Anstruther 82.
- Ap.**—Apedale 44; Appleby 69-75.
- Ar.**—Arundel 21; Askrigg 69-74; Armagh 88; Arklow 92.
- As.**—Ashford 20, 21; Abersychan 59-63; Alston 69-75.
- At.**—Abertillery 59, 60; Atherton 64-73; Athlone 92.
- Ath.**—Atherstone.
- Au.**—Auchterarder 80, 83; Aughnacloy 88.
- A.-u.-L.**—Ashton-under-Lyme.
- Aum.**—Auchtermuchty.
- Aw.**—Alnwick.
- Ax.**—Alexandria.
- Ay.**—Aylesbury 20; Athy 74.
- A. & P.**—Abergele and Pensarn.
- B.**—Brentford 10, 20 [on Brent]; Braintree 20 [on Pant]; Bedford 20 [on Ouse], 34; Battle 21; Bournemouth 25, 31; Birmingham 42, 43 [S. part], 48; Bolton 38 [N. part]; Biddulph 44; Bourne 45; Bampton 51 [W. margin]; Bath 51 [central part]; Bodmin 56; Barnstaple 57 [on Taw]; Bude 57 [on W. coast]; Blaenavon 59 [E. part of S. Wales coalfield]; Bristol 59 [S. of Bristol Channel], 60; Ammanford Bettws 59, 60 [W. part of S. Wales coalfield]; Birkenhead 61; Bootle 63; Bolton 64-73; Blackpool 69; Barnsley 74; Beith 77, 80; Ballater 84 [inland]; Banff

- 84 [on coast]; Belfast 88; Ballinrobe 91 [near L. Mask]; Boyle 91 [near L. Key]; Ballinamore 92 [inland]; Bray 92 [on coast]; Buttevant 94; Bride 97.
- B.A.**—Blaenavon 48-63; Bishop's Auckland 73-75; Blair Atholl 83, 84.
- Ba.**—Basingstoke 20 [on Loddon], 31; Banbury 20 [on Cherwell], 48; Batley 43, 66-74; Barmouth 61; Bath 63; Barnsley 66; Bangor 88; Ballina 91.
- B.B.**—Bessbrook.
- Bb.**—Bracebridge 45; Blackburn 64-73; Balbriggan 92.
- B.C.**—Burnham-on-Crouch 10, 36; Bishop's Castle 60-63; Barnard Castle 73, 75; Balmoral Castle 84.
- Bc.**—Bicester 20; Brecon 59, 60; Ballyclare 88 [inland]; Ballycastle 88 [on coast], 91.
- Bd.**—Brewood 42; Brandon 45; Blaydon 73, 75; Ballaghaderreen 91.
- B.E.**—Bury St. Edmunds.
- Be.**—Beaminster 51; Bellingham 69; Ballinasloe 91.
- B.F.**—Briton Ferry 59, 60; Broughty Ferry 83.
- Bf.**—Blandford 51; Bideford 57; Belford 77.
- Bg.**—Bognor 21; Brigg 45, 73, 74; Bromsgrove 48; Bridgend 59, 60; Bangor 61; Biggar 77; Baginbaldstown 92.
- B.H.**—Brierley Hill.
- Bh.**—Burnham 57; Brighouse 64-74; Ballinahinch 88; Bailieborough 92.
- Bi.**—Bilston 42; Bingham 45, 73 [near Trent]; Birkenhead 64; Bingley 66-74 [in Airedale].
- B.-in-F.**—Barrow-in-Furness and Broughton-in-Furness [former S. of latter] 69, 73.
- B.-in-K.**—Burton-in-Kendal 69, 73.
- Bk.**—Brighouse 43; Brecon 48; Birkenhead 63-73.
- Bl.**—Bristol 51; Bala 61; Blackpool 64-73 [W. coast]; Bollington 73 [inland], 74; Blyth 73 [E. coast], 75; Bellingham 77; Blairgowrie 83.
- Bm.**—Brynmawr 48, 59, 60; Burnham 51; Beaumaris 61; Ballymena 88; Ballymote 91.
- Bn.**—Bilston 43 [S.W. part]; Barnsley 43 [N. part], 73 [S. part]; Bridgnorth 48, 63; Bowness 69, 73 [N. part]; Banagher 92; Bandon 94.
- B. N. C. R.**—Belfast and Northern Counties (Midland) Railway.
- Bo.**—Boston 34-45; Bootle 66; Bowes 69, 73, 75; Bolsover 73, 74.
- B.-on-A.**—Bradford-on-Avon.
- B.-on-T.**—Burton-on-Trent 48; Berwick-on-Tweed 77.
- B. or P.**—Birr or Parsonstown.
- Bp.**—Bacup 43 [N.W.], 63-69, 73 [Lancs.]; Belper 43 [Central], 73 [Derbysh.].
- B.R.**—Black Rock.
- Br.**—Brentwood 10, 20; Brighton 21; Bridport 25; Brentwood 36; Brownhills 42; Broughton 45; Bridgwater 51; Bromyard 60; Bristol 63; Bradford 64-74 [inland]; Bridlington 73, 74 [coast]; Brampton 77; Brodick 77, 80.
- B.S.**—Bishop's Stortford 10, 20; Budleigh Salterton 57.
- Bs.**—Brightlingsea 10; Boston 73.
- Bt.**—Bawtry 45, 73, 74; Bruton 51; Bampton 57; Bethesda 61; Bootle 64, 73 [S. part]; Brampton 69, 73 [N. part], 75; Belturbet 92.
- Bu.**—Buckingham 20, 34; Burslem 44, 73; Buckfastleigh 57; Burnley 64-74; Buckie 84, 85; Bushmills 88.
- B.-upon-H.**—Barton-upon-Humber.
- B.-up-T.**—Burton-on-Trent.

- Bv.**—Beverley 73, 74; Ballyvaghan 91.
- B.W.**—Burnham Market 45; Builth Wells 60.
- Bw.**—Bridgwater 57; Bakewell 73, 74.
- Bx.**—Buxton 43, 73; Brixham 57.
- By.**—Bromley 20; Bury 43, 64-74; Barry 51-60; Bromyard 63; Ballymoney 88; Ballybay 92; Bantry 94.
- B. y. C.**—Bettws-y-Coed.
- B. & F.**—Brumby and Frodingham.
- C.**—Cirencester 20 [on Churn]; Cambridge 20 [on Cam], 34, 36, 45; Chatham 21; Chard 25, 51; Chichester 31; Coleshill 37; Cheadle 43; Crewe 44; Coventry 48; Calne 51; Camborne 56; Cardiff 57-63 [on Taff]; Carmarthen 59, 60 [on Towy]; Conway 61; Chester 63, 64 [W. part], 73 [on Dee]; Cheadle 64 [E. part], 73 [near S. margin]; Clitheroe 69 [inland]; Cartmell 69 [near coast], 73 [N. part]; Carlisle 77; Cullen 84; Castlerea 91; Clara 92; Cork 94; Castletown 97.
- C.A.**—Craven Arms 60; Coupar Angus 83.
- Ca.**—Castleford 43, 66-74; Caerphilly 51-60; Caher 92.
- C.B.**—Castletown Berehaven.
- Cb.**—Canterbury 21; Cowbridge 51-60; Corbridge 69-77; Clydebank 80, 82; Castlebar 91; Castleblayney 92.
- Cc.**—Christchurch 31; Criccieth 61; Castlecomer 92.
- C.D.**—Castle Douglas.
- Cd.**—Clevedon.
- C.E.**—Conwil-in-Elvet.
- C F.**—Chapel-en-le-Frith.
- Cf.**—Chelmsford 10, 20; Carnforth 69, 73; Carrickfergus 88; Clifden 91.
- Cg.**—Congleton 43, 44, 63-74; Cardigan 60; Carrigallen 92.
- CH.**—Chorley.
- Ch.**—Chatham 10, 20 [near E. margin]; Cheltenham 20 [near W. margin], 48; Chichester 21; Chelmsford 36; Chesterfield 43, 73, 74; Cheswardine 44; Chester-ton 45; Chippenham 51; Charles-town 56; Chard 57; Chester 61; Cannock 64; Chorley 66, 69.
- C.I.**—Canvey Island.
- Ck.**—Cleckheaton 43-74; Carrickmacross 92; Clonakilty 94.
- Cl.**—Clacton 10, 36; Cleethorpes 45, 73 [coast]; Caerleon 51, 59-63; Clovelly 57; Clitheroe 66, 73 [on Ribble], 74; Carlisle 69, 73 [on Eden]; Chorley 63; Carlisle 77, 80; Clones 88, 92; Claremorris, 91; Clonmel, 94.
- C.M.**—Cleobury Mortimer 60, 63; Cleator Moor 69.
- Cm.**—Camelford 53; Cocker-mouth 69, 77; Comrie 83; Clonmel 92 [S. part]; Crossmaglen 92 [N. part].
- Cn.**—Croydon 20; Cannock 42, 43; Carnarvon 61.
- Co.**—Colchester 10, 20, 34, 36; Cowes 31; Coventry 43; Colwyn 61; Colne 66-74; Coldstream 75; Consett 77; Coleraine 88; Cootehill 92.
- C. on S.**—Carrick-on-Shannon 91; Carrick-on-Suir 92, 94.
- C. on Sh.**—Carrick-on-Shannon 92.
- C. & O. R.**—Callander and Oban Railway.
- Cp.**—Chippenham 20; Cupar 82, 83; Cappelquin 94.
- C.R.**—Cambrian Railway (in Wales); Caledonian Railway (in Scotland).
- Cr.**—Croydon 10, 21; Cricklade 20; Cromer 36; Crowle 45, 73, 74; Crediton 57; Crickhowell 59, 60; Crewe 63-73; Crail 82; Crieff 83; Cromarty 84, 85.
- C.S.**—Church Stretton 48, 61, 63; Chipping Sodbury 51; Chester-le-Street 75.

Cs.—Chepstow 51-63; Consett 73, 75; Carstairs 77, 80; Cahirciveen 94.

Ct.—Chatteris 45; Coatbridge 80, 82.

Cu.—Cumnock 77, 80 [S. part]; Culross 80 [N. part], 82.

Cv.—Coalville 43, 48; Charleville 91, 94; Cavan 92.

Cw.—Corwen 61, 64; Carlow 92.

Cy.—Chertsey 20; Collooney 88, 91.

D.—Dorking 20; Dover 21; Dorchester 30, 31, 51; Dunwich 36; Darlaston 42; Dudley 48 [central part]; Dowlais 48 [in Taff basin], 59, 60; Devonport 57; Denbigh 61; Darwen 64-73; Durham 73, 75; Dumfries 77; Dunfermline 80, 82; Dingwall 84, 85; Donegal 88; Dublin 92; Dingle 94; Douglas 97.

Da.—Dawley.

Db.—Dewsbury 43-74; Dalbeattie 77.

Dc.—Doncaster.

Dd.—Dundee 83; Dundalk 92.

De.—Deal.

Df.—Dartford.

Dg.—Dolgelley.

Di.—Darlaston 43; Bollington 64.

D. in F.—Dalton-in-Furness.

Dk.—Dorking.

Di.—Dawlish 57; Darlington 73, 75.

D.M.—Downham Market.

Dm.—Dartmouth 57; Dumbarton 80, 82.

Dn.—Dunoon 80; Dunkeld 83; Dornoch 85; Dungannon 88.

Do.—Donaghadee.

Dp.—Downpatrick.

Dr.—Droitwich 48; Dromore 88; Drogheda 92.

D.S.E.R.—Dublin and South-Eastern Railway.

Du.—Dudley 42; Dursley 51; Dun-
garvan 94.

Dv.—Devizes.

Dy.—Derby 43-73; Dalry 80; Dy-
sart 82; Dunmanway 94.

E.—Enfield 10; Evesham 20, 48; Eastbourne 21; Exmouth 25; Ely 34, 36, 45; Erdington 42; Eccles 43 [Lancs.], 73 [do.]; Elland 43 [Yorks], 64, 66, 73 [do.], 74; Ecclelland 44; Exeter 51, 57; Ellesmere 61; Ecclefechan 69, 73 [Scotland], 77; Edinburgh 82; Ennis 91.

Ec.—Eccles.

Ed.—Erdington 43; Edenberry 92.

E.G.—East Grinstead.

E.g.—Elgin.

El.—Elie 82, 83; Ellon 84.

Em.—Exmouth 57; Ellesmere 63, 64, 73; Egremont 69.

En.—Enfield 20, 36; Endon 44; Enniskillen 88; Ennistimon 91; Enniscorthy 92.

Ep.—Epping.

E.R.—East Retford.

Er.—Erdington.

Es.—Esher.

E.V.—Ebbw Vale.

Ey.—Easky.

F.—Farnham 20, 21; Felixstowe 36; Faseley 42; Farnworth 43, 64, 66, 69 [inland], 73 [inland], 74; Frome 51; Falmouth 56; Fishguard 60; Festiniog 61; Fleetwood 69 [on coast], 73 [on coast]; Falkirk 80, 82; Forres 84, 85; Fintona 88; Fethard 92; Fermoy 94.

F.A.—Fort Augustus.

Ff.—Fairford 20; Forfar 83.

Fi.—Filey.

Fk.—Folkestone.

Fl.—Flint 62, 64, 73; Fleetwood 66; Felling 73, 75; Falkland 83.

Fo.—Fochabers.

Fr.—Faringdon 20; Fraserburgh 84.

- Ft.**—Fortrose 84, 85; Fethard 94.
Fv.—Faversham.
F.W.—Fort William.
Fw.—Fowey.
- G.**—Gravesend 10, 20 [on Thames], 36; Gloucester 20 [on Severn], 48; Guildford 21; Grantham 34, 43, 73 [inland]; Grimsby 45, 73 [on coast]; Glyncorrwg 59; Gateshead 77 [near E. margin]; Greenlaw 77 [near N. margin]; Glasgow 80, 82; Golspie 85; Gort 88.
- Ga.**—Gainsborough 45-74; Galashiels 77.
- Gb.**—Guisborough.
- G.C.**—Garden City, Letchworth 20, 34, 36; Grand Canal 92.
- G.C.R.**—Great Central Railway.
- G.D.**—Great Driffield.
- Gd.**—Guildford.
- G.E.R.**—Great Eastern Railway.
- Gh.**—Gateshead.
- Gl.**—Glastonbury 51; Gloucester 63; Glossop 64-74; Gairloch 85.
- G.M.**—Great Malvern.
- Gm.**—Godalming 20, 21; Godmanchester 45.
- G.N.R.**—Great Northern Railway.
- G.N.R.I.**—Great Northern Railway (Ireland).
- G.N.S.R.**—Great North of Scotland Railway.
- Go.**—Goole 43-74; Gourrock 80.
- G. of F.**—Gatehouse of Fleet.
- Gr.**—Greenwich 10, 20; Grantham 45; Garstang 69-73; Greenock 80; Granard 92.
- G. S. W. R.**—Glasgow and South-Western Railway (in Scotland); Great Southern and Western Railway (in Ireland).
- Gt.**—Garston.
- Gt. H.**—Great Horwood.
- Gt. T.**—Great Torrington.
- Gv.**—Girvan.
- Gw.**—Galway.
- G.W.R.**—Great Western Railway.
- Gy.**—Gorey.
- H.**—Harwich 10, 36 [on coast]; Henley 20 [on Thames]; Hounslow 20 [near Brent]; Hastings 21; Honiton 25, 51, 57; Huntingdon 34, 36 [on Ouse]; Halesowen 42; Halifax 43, 64, 66, 74 [W. part]; Horton 44; Hull 45, 73 [on Humber], 74 [E. part]; Hinckley 48; Hayle 56; Hay 60; Holt 61, 63, 64 [on Dee], 73 [on Dee]; Holywell 64 [on coast]; Haltwhistle 69; Hartlepool 73 [N.E. coast], 75; Hamilton 77-82; Huntly 84; Helmsdale 85.
- Ha.**—Haverhill 20; Haslingden 66; Hawes 69-74.
- HB.**—Holbeach.
- Hb.**—Highbridge 51, 57; Helensburgh 80.
- Hc.**—Horncastle.
- Hd.**—Hedon 45, 73; Haddington 67, 82.
- He.**—Hertford.
- Hf.**—Hertford 10, 20; Huddersfield 43, 64, 66, 73 [on Calder], 74; Hereford 48, 60, 63; Horsforth 73 [in Airedale]; Headford 91.
- Hg.**—Hungerford 20; Harrogate 73, 74.
- Hh.**—Holyhead 61; Hexham 69, 73, 75; Horsforth 74.
- Hi.**—Hitchin.
- Hk.**—Hinckley 43; Hawkshead 69, 73.
- Hi.**—Halifax 73 [S. part]; Helmsley 73 [N. part], 74.
- Hm.**—Horsham.
- HN.**—Hoyland.
- Hn.**—Heanor 43, 73 [in Derbyshire Coalfield]; Hanley 44, 73 [in Potteries]; Huntingdon 45; Harrington 69.
- Ho.**—Horwich 64-69, 73 [Lancashire]; Hornsea 73 [E. coast].

- H.R.**—Highland Railway.
- Ha.**—Haslemere 21; Hunstanton 45; Helston 56; Horsforth 66; Haslingden 69, 73 [inland]; Heysham 69, 73 [on coast].
- Ht.**—Heavitree 57; Hartington 64-74; Hilltown 92.
- H.W.**—High Wycombe 20; Haverfordwest 60.
- Hw.**—Handsworth 43 [S. part]; Heywood 43 [N. part], 64-69, 73 [inland, S. part], 74; Holsworthy 57; Holywell 61, 73 [on coast]; Haltwhistle 73 [inland, N. part], 75, 77 [on S. Tyne]; Hawick 77 [on Teviot]; Holywood 88.
- Hx.**—Hexham.
- Hy.**—Hythe 21; Hyde 43-74.
- I.**—Ipswich 34, 36; Ilkeston 43, 48, 73; Ilchester 51; Ilfracombe 57; Irvine 77, 80; Inverkeithing 82; Inverness 84, 85.
- Ib.**—Ivybridge 57; Bervie 84.
- I.G.**—Isle of Grain.
- Ig.**—Invergordon.
- Im.**—Ilminster.
- In.**—Inveraray.
- Ir.**—Inverurie.
- J.**—Jedburgh 77; Johnstone 80; Jurby 97.
- Jr.**—Jarrow.
- K.**—Kingston 10, 20; Kettering 34, 43, 45; Kidsgrove 44; Kidderminster 48; Keynsham 51; Kingsbridge 57; Knighton 61; Knottingley 66, 73 [S. part], 74; Kendal 69, [N. part]; Kelso 77; Kinghorn 82; Keith 84 [Deveron basin]; Kingussie 84 [Strathspey]; Kells 92; Killorglin 94.
- Kb.**—Kimbolton.
- Kc.**—Kirkcaldy.
- Kd.**—Kidderminster 63; Kildare 92.
- Kf.**—Kilfinnane.
- Ki.**—Kington 60, 63; Keighley 74; Kintore 84; Killala 91.
- Kk.**—Kirkcudbright 77; Kilkenny 92.
- K.L.**—King's Lynn 34-45; Kirkby Lonsdale 69, 73.
- Kl.**—Keighley 66, 73; Kilsyth 82; Killalo 91; Kilkeel 92.
- Km.**—Kilmarnock 77, 80; Kenmare 94.
- K.N.**—King's Norton.
- Kn.**—Knighton 60, 63 [central part]; Knutsford 63 [N. part], 64-74; Kingstown 92.
- Ko.**—Kirkoswald.
- Kr.**—Kinross 83 [near S. margin]; Kirriemuir 83 [in Strathmore]; Kilrush 91.
- K.S.**—Kirkby Stephen.
- Ks.**—Kinsale.
- Kt.**—Kirkintilloch 80, 82; Kanturk 94.
- Kw.**—Kidwelly 59, 60; Keswick 69, 73.
- Ky.**—Killyleagh 88; Killarney 94.
- L.**—Leigh-on-Sea 10; London 10, 20, 21, 36; Lulworth 25, 31; Leicester 34, 48; Lichfield 42; Leek 44; Lincoln 45, 73 [E. part], 74 [S.E. corner]; Ludgvan 56; Launceston 57; Llandeilo 59; Llanelly 60; Llandudno 61 [on coast]; Llanfyllin 61 [inland]; Llantarnam 63; Liverpool 64, 73 [W. part]; Leeds 66, 73 [central part], 74 [centre]; Langholm 73 [N. part]; Lanark 77, 80 [inland]; Largs 80 [on coast]; Leith 82; Lossiemouth 84, 85; Londonderry 88; Limerick 91; Listowel 94; Laxey 97.
- La.**—Larne.
- Lb.**—Loughborough 43, 48; Leyburn 73, 74; Lockerbie 77; Lybster 85; Lisburn 88.
- L.B.S.C.R.**—London, Brighton and South Coast Railway.

- Lc.**—Lancaster.
- L.C.D.R.**—London, Chatham and Dover Railway.
- Ld.**—Lechlade 20; Ludlow 48, 60 [N.W. corner]; Llandovery 59, 60 [on Towy]; Llanidloes 60 [on Severn], 61; Ledbury 63; Lauderdale, 77, 82.
- Ldl.**—Llandeilo.
- L.E.**—Long Eaton.
- Le.**—Leigh.
- Lf.**—Llansaintffraid 60; Llanfairfechan 61; Llanfyllin 64; Longford 92.
- Lg.**—Lochgilthead.
- Lh.**—Littlehampton 21; Langholm 77.
- Li.**—Lichfield.
- Lk.**—Leek 43, 64-74; Liskeard 57; Laurencekirk 84; Letterkenny 88.
- Ll.**—Llangollen 61, 64, 73; Ludlow 63; Linlithgow 80, 82.
- Lm.**—Leominster 48, 60, 63; Lymouth 57; Lamlash 77, 80; Lismore 94.
- Ln.**—Leamington 48; Llanelly 59.
- L.N.W.R.**—London and North-Western Railway.
- Lo.**—Lowestoft 36; Longton 44, 73 [S. margin]; Louth 45, 73 [E. margin]; Looe 57; Longtown 66, 73 [N. part]; Lochmaben 77.
- Lp.**—Langport 51; Lampeter 60.
- L.R.**—Lyne Regis.
- Lr.**—Llanrwst 61; Llanfrehfa 63.
- L.S.**—Long Sutton.
- Ls.**—Llandyssil.
- L.S.W.R.**—London and South-Western Railway.
- Lt.**—Leicester 43 [near centre]; Leamington 43 [S. margin]; Loftus 73; Listowel 91.
- Lu.**—Luton 20; Lurgan 88.
- Lv.**—Liverpool 61-66; Leven 82, 83.
- L.W.**—Llandrindod Wells.
- Lw.**—Lewes 21; Lostwithiel 57.
- Ly.**—Lympe 21; Ledbury 48; Lytham 64-73.
- L. & Y. R.**—Lancashire and Yorkshire Railway.
- M.**—Maidstone 10, 20 [on Medway], 21; Marlow 20 [on Thames]; Malvern 20 [W. margin], 48 [near Severn]; March 34, 36, 45; Manchester 43, 66, 74; Macclesfield 44; Monmouth 48 [on Wye], 59, 60, 63; Marlborough 51 [E. margin]; Minehead 51 [W. margin], 57; Montgomery 61 [S. part]; Mold 61 [N. part], 64, 73 [S. part]; Middleton-in-Teesdale 69, 73 [N. part], 75; Moniaive 77; Musselburgh 82; Montrose 84; Monaghan 88; Mullingar 92; Mallow 94.
- M.A.**—Mountain Ash.
- Ma.**—Madeley 44; Machynlleth 61; Manchester 73 [S. part]; Masham 73 [N. part], 74; Macduff 84.
- M.B.**—Menai Bridge.
- Mb.**—Mablethorpe 45; Maybole 78, 80; Maryborough 74.
- Mc.**—Macclesfield 43, 59, 60, 64, 73 [inland], 74; Morecambe 69, 73 [on coast]; Macroom 94.
- M.D.**—Market Drayton.
- Md.**—Maidenhead 20; Middlesbrough 73, 75.
- Mf.**—Mansfield 43 [near centre], 73 [Trent basin], 74 [do.]; Mirfield 43 [near N. margin], 66, 73 [on Calder], 74 [do.]; Marshfield 49; Moffat 77.
- Mg.**—Margate 10, 21; Margam 59, 60; Mossley 74; Maghera 88.
- M.G.W.R.**—Midland Great Western Railway (Ireland).
- M.H.**—Market Harborough 34-45; Milford Haven 60; Manor Hamilton 88.
- Mi.**—Middlewich 44; Middleton (all other maps).

- M.-in-T.**—Middleton-in-Teesdale.
Mk.—Matlock.
Ml.—Maldon 36; Milton 44; Mil-
 lom 69, 73.
M.M.—Melton Mowbray 34-45;
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Mm.—Mountmellick.
Mn.—Milnathort 80, 82; Maynooth
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Mo.—Mossley 43 [Mersey basin];
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M.P.—Milborne Port.
Mp.—Malpas 63, 64, 73 [S. part];
 Morpeth 73 [N. part], 75, 77.
M.R.—Midland Railway (generally);
 Market Rasen 45-74.
Ms.—Maesteg 59, 60; Mossley 64-
 73; Millstreet 94.
M.T.—Merthyr Tydvil.
Mt.—Montacute 51; Mitchelstown
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M.W.—Market Weighton.
Mw.—Middlewich.
Mx.—Maxwelltown.
My.—Maryport.
- N.**—Newbury 20; Newhaven 21;
 Newport, I.W. 31; Northampton
 34, 45; Norwich 36; Nottingham
 43, 48, 73; Newport, Mon. 51,
 59-63; Newquay 56; Northam
 57; Newcastle-on-Tyne 73, 75;
 Nairn 84, 85; Newtownards 88
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 gin]; Naas 92; Newcastle 94.
- N.A.**—Newton Abbot.
Na.—Northallerton.
N.B.—North Berwick 82; New-
 town Butler 88.
Nb.—Newbury 31; Narberth 60;
 Newbridge 92.
N.B.R.—North British Railway.
N.E.—Newcastle Emlyn.
- Ne.**—Newark 43, 45, 73, 74; Neath
 59, 60; Newport, Salop 64; New-
 castle 91.
N.E.R.—North-Eastern Railway.
N.G.—New Galloway.
N.H.—Newtown Hamilton.
Nh.—Newnham.
N.-in-M.—Newton-in-Makerfield
 (Newton-le-Willows).
N.L.—Limavady.
Nl.—Neyland.
N.M.—New Malton.
Nm.—Newmarket 36, 45; Norman-
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Nn.—Nantwich 63-73; Nenagh 91.
No.—Nuneaton.
Np.—Newport, Cardigan.
N.Q.—New Quay.
N.R.—New Radnor 60; New Ross
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N.S.R.—North Staffordshire Rail-
 way.
Ns.—Nelson.
Nt.—Neston.
Nu.—Nuneaton.
N.-u.-L.—Newcastle-under-Lyme.
N.-u.-T.—Newcastle-on-Tyne.
Nw.—Northwich.
Ny.—Newry.
N. & B.—Nantyglo and Blaina.
N. & L.—Newtown and Llanllw-
 chain.
- O.**—Oxford 20; Oakham 34, 45;
 Orford 36; Oldbury 42; Oldham
 43, 64-74; Oakengates 48, 63;
 Okehampton 57; Oystermouth
 60; Oswestry 61; Omagh 88;
 Oldcastle 92.
O. & G.—Ogmore and Garw.
O.H.—Old Hill.
Ok.—Ormskirk.
Ol.—Olney.

- Os.**—Ossett 43, 66-74; Oswestry 48-64.
- O. St. M.**—Ottery St. Mary.
- Ou.**—Oundle.
- Ow.**—Oswaldwistle.
- Ox.**—Oxford.
- P.**—Portsmouth 21, 31; Poole 25; Peterborough 34-45; Pontypridd 51, 59, 60 [E. part]; Penzance 56; Plymouth 57; Pembroke 60 [W. part]; Pwllheli 61; Preston 64-73; Peebles 77; Perth 82, 83; Peterhead 84; Portadown 88; Portarlinton 92; Peel 97.
- Pa.**—Paul 56; Panteg 51, 59-63; Padiham 64-74.
- Pb.**—Portobello.
- Pc.**—Porthcawl 57-60; Portmadoc 61.
- P.E.**—Port Erin.
- Pe.**—Pentewan.
- Pf.**—Petersfield 21, Portaferry 88.
- P.G.**—Port Glasgow.
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- P.R.**—Princes Risborough.
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- P.S.**—Pudsey.
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- P.W.**—Passage West.
- P.y.**—Paisley.
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- R.**—Rochester 10, 20 [on Medway], 21; Reading 20 [on Kennet]; Ryde 31; Romford 36; Rochdale 43, 64 [N. part], 66-74; Ramsey 45; Rugby 48 [on Avon]; Redditch 48 [on Arrow]; Radstock 51; Redruth 56; Rhondda 59, 60; Rhyl 61; Ruthin 64 [W. part]; Rosyth 80, 82; Roscommon 91; Rush 92 [N. part]; Rosslare 92 [S. part]; Ramsey 97.
- Ra.**—Radcliffe.
- Rb.**—Rugby 43; Ruabon 61, 64; Rothbury 73, 75; Rotherham 74.
- R.C.**—Runcorn 61; Royal Canal 92.
- Rc.**—Redcar 73, 75; Rockcorry 92.
- Rd.**—Rushden 45; Rathdowney 92.
- Re.**—Reigate 21; Reeth 73-75.
- Rf.**—Romford 10, 20; Rathfriland 88.
- Rg.**—Ramsgate 10, 21; Reigate 20; Rugeley 64.
- Rh.**—Rotherham 43, 66, 73; Rhymney 48-60.
- Ri.**—Ripley.
- Rk.**—Rickmansworth 20; Rathkeale 91.
- Rm.**—Richmond, Surrey 10, 20; Romney 21; Ramsbottom 43 [N.W. corner], 64, 66 [near centre], 69, 73 [Mersey basin], 74 [Mersey basin]; Rawmarsh 43 [on Don], 66 [W. part], 73 [on Don], 74 [on Don]; Richmond, Yorks 73 [N. part], 74 [N. part], 75; Ramelton 88.
- Ro.**—Ross.
- Rp.**—Ripon.
- R.R.**—Rowley Regis.
- Rs.**—Roscrea.
- Rt.**—Rawtenstall.
- Ru.**—Ruskington 45, 73 [S.E. part]; Ruthin 61; Runcorn 66, 73 [W. part].
- Rw.**—Ringwood.

Ry.—Royston 20; Rye 21; Rhayader 60; Rothesay 80.

S.—Stratford 10; Sevenoaks 20; Sandgate 21; Seaton 25; Southampton 31; Sheffield 43, 73 [on Don], 74 [on Don]; Stafford 44; Shrewsbury 48, 61, 63; Salisbury 51; Stratton 57 [near W. coast]; Saltash 57 [near S. coast]; Swansea 59, 60; Southport 64, 66, 69 [on coast], 73 [W. coast]; Skipton 69 [inland]; Selby 73 [on Ouse], 74 [on Ouse]; Saltburn 73 [E. coast], 75; Saltcoats 77 [on coast]; Strathaven 77 [inland], 80; Stonehaven 84; Sligo 88, 91.

Sa.—Salisbury 20, 31; Sandwich 21; Salford 43, 64-74; Sandbach 44.

S.B.—Sowerby Bridge 43, 64-74; Sutton Bridge 44.

Sh.—Stourbridge 42, 48; Spilsby 45; Sherborne 51 [Parret basin]; Stalbridge 51 [Stour basin]; Scarborough 73, 74.

S.C.—Sutton Coldfield.

Sc.—Scunthorpe 45, 73, 74; Salcombe 57.

Sd.—Sandown 31; Sunderland 73, 75.

Se.—Seaton 57; Settle 69-74.

S.E.R.—South-Eastern Railway.

Sf.—Stafford 43 [on Sow]; Stretford 43 [in Mersey basin], 63-66, 73 [S. part], 74; Sedgefield 73 [N. part], 75; Swineford 91.

S.H.—Seaham Harbour.

Sh.—Sheerness 20; Shenstone 42; Shifnal 48, 63; Shaftesbury 31, 51; Shrewsbury 64; Sheffield 66; Stanhope 69, 73 [in Weardale], 75 [do.]; Shildon 73 [near B.A.], 75 [do.]; Stockport 74.

Si.—Sittingbourne 20; Sidmouth 25, 57.

S. in A.—Sutton-in-Ashfield.

Sk.—Stockport 43-66, 73 [Mersey basin]; Skipton 73 [Airedale], 74; Selkirk 77; Skerries 92; Skibbereen 94.

Sl.—Sleaford 45, 73 [Witham basin]; Sale 43, 63-66, 73 [Mersey basin], 74; Stokesley 73 [Tees basin], 74, 75.

S.M.—Shepton Mallet 51; South Molton 57.

Sm.—Shoreham 21; Smethwick 42-48.

S.N.—Sturminster Newton.

Sn.—Sheerness 10, 21; Skegness 45; Stone 64.

So.—Southend.

S. on A.—Stratford-on-Avon.

S. on T.—Stoke-on-Trent 43, 44, 73 [S. part]; Stockton-on-Tees 73 [N. part], 75.

S.P.—South Petherton.

Sp.—Spalding 34-45; Shipley 66-74.

Sq.—Sanquhar.

S.S.—South Shields.

St.—Staines 20 [on Thames]; Stonehenge 20 [on Salisbury Plain], 31; Stamford 34, 45; Staleybridge 43 [Mersey basin], 64, 66, 73 [Mersey basin], 74; Stone 43 [on Trent], 44, 73 [on Trent]; Stroud 48 [near S. margin], 63; Stafford 48 [near N. margin]; Stonehouse 57; Stanhope 77 [E. part]; Stranraer 77 [W. part]; Stirling 80, 82; Stornoway 85; Strabane 88; Stradone 92.

St. A.—St. Alban's 10, 20; St. Austell 56; St. Andrews 82, 83.

St. H.—St. Helen's.

St. I.—St. Ives.

St. J.—St. Just.

St. J.C.—St. John's Chapel.

St. N.—St. Neot's.

Su.—Sudbury 20 [on Stour]; Sutton 20 [near N. Downs].

Sv.—Sevenoaks 21; Silverdale 44.

S.W.—Swinton.

Sw.—Swindon 20, 51; Swanage 25, 31; Swinton 43 [Don basin], 66 [E. part], 73 [Don basin]; Saddleworth 43 [Mersey basin], 64, 66 [near centre], 74 [Mersey basin]; Swaffham 45 [near E. margin]; Southwell 45 [near W. margin], 73 [Trent basin], 74 [do.]; Swanlinbar 88, 92.

S. & D.R.—Somerset and Dorset Railway.

S. & P.—Swinton and Pendlebury.

T.—Tonbridge 20 [on Medway]; Tewkesbury 20 [on Severn], 48; Thetford 36; Tipton 42; Trentham 44; Tredegar 48, 59, 60; Trowbridge 51 [N.E. of centre]; Taunton 51 [S.W. of centre], 57 [on Tone]; Truro 56; Tiverton 57 [on Exe]; Towyne 61 [on coast]; Tarporley 61 [inland], 63, 64, 73 [Mersey basin]; Tadcaster 66, 73 [on Wharfe], 74; Troon 77, 80; Turriff 84; Tain 85; Tanderagee 88; Tuam 91; Trim 92; Tralee 94.

Ta.—Tallow.

Tb.—Trowbridge 20; Tetbury 51; Tarbert 80.

Tc.—Templecombe.

Te.—Thetford 45; Tenby 60.

Tf.—Tuxford.

Tg.—Talgarth.

Th.—Thornbury 51-63; Thirsk 73, 74; Thornhill 77; Thurso 85; Thurles 92.

Ti.—Tickhill.

Tl.—Tilbury 10-36; Tyldesley 64, 66.

Tm.—Thame 20; Tamworth 42, 43; Teignmouth 57; Tynemouth 73, 75; Templemore 92 [near Devils-bit Mt.]; Tullamore 92 [near Bog of Allen].

Tn.—Tring 20; Totnes 57.

To.—Todmorden.

T. on T.—Thornaby on Tees.

Tp.—Tipton 43; Tayport 83; Tipperary 91, 94.

Tq.—Torquay.

Tr.—Tregaron 60; Tralee 91; Tra-
more 92.

Tt.—Tavistock.

Tu.—Tunstall 44; Tullow 92.

Tv.—Tiverton.

T.W.—Tunbridge Wells.

Tw.—Tideswell.

U.—Uxbridge 20; Uppingham 45; Usk 59-63; Uttoxeter 73; Ullapool 85.

U.C.—Ulster Canal.

Ut.—Uttoxeter.

V.—Ventnor.

W.—Woolwich 10; Worcester 20 [on Severn], 48; Windsor 20, [on Thames]; Worthing 21; Weymouth 25, 31; Wellingborough 34, 43 [S.E. part], 45; Wednesbury 42; Withington 43 [N.W. part], 63, 64 [E. of centre], 73 [Mersey basin], 74; Watchet 51 [on coast]; Wells 51 [inland]; Wadebridge 56; Wellington 57; Welshpool 61; Wigan 64 [W. of centre], 66, 69, 73 [near Pm.]; Wolsingham 73 [in Weardale], 75; Wigton 77 [near S. margin]; Wishaw 77 [near N. margin], 80, 82; Wick 85.

W.A.—White Abbey.

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W.B.—West Bromwich 42-48; Wootton Bassett 51.

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Wc.—Worcester.

Wd.—Wendover.

We.—Wellington 48, 63; Welshpool 64; Wallsend 73, 75.

Wf.—Wallingford 20; Wakefield 43-74; Waterford 92.

Wg.—Wantage 20; Wigtown 77.

W.H.—West Houghton 64-69, 73 [S. part]; West Hartlepool 73 [N. part], 75.

Wh.—Whitstable 10, 21; Wolverhampton 43; Whitchurch 61-64; Whitehaven 69; Whithorn 77.

Wi.—Witham 20; Willenhall 42, 43; Winterton 45, 73, 74; Wilton 51; Wiveliscombe 57; Widnes 61-64; Withington 66.

Wit.—Widnes, 59.

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W.W.—Wombwell.

Ww.—Wombwell 43, 66, 73; Warwick 48.

Wx.—Wexford.

Wy.—Wetherby.

Y.—Yeovil 25, 31, 51; Yarmouth 36; York 73, 74; Youghal 94.

Ym.—Yarmouth 31.

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